INTEGRATED RENEWABLE RESOURCE MANAGEMENT FOR U.S. INSULAR AREAS

Volume II: Commissioned Papers

Part B: Agriculture - Pacific

1. Traditional Agriculture and Resource Management Systems in the High Islands of Micronesia
(Marjorie V.C. Falanruw)

2. Commerical Crop Production Technologies and Development Potentials for U.S.-Affiliated Pacific Islands
(Bill Raynor)

3. Role of Smallholders in Agricultural Development in the U.S.-Affiliated Pacific Islands
(Robert Lucas)

4. An Analysis of Black Pepper Production in Ponape
(Meredith Glenn)

5. Assessment of Livestock Production Technologies in Micronesia and Feasibility for Locally Produced Pig Feed on Ponape
(Miklos Szentkiralyi)

6. Food and Feed Processing Technologies in the United States Insular Areas of the Pacific
(Philip G. Stiles)

7. Economic Pests and Pest Management Technologies Suitable for U.S.-Affiliated Pacific Islands
(Agnes Vargo)

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Background Paper No. 1

TRADITIONAL AGRICULTURE AND RESOURCE MANAGEMENT SYSTEMS IN THE HIGH ISLANDS OF MICRONESIA

by

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Abstract

Traditional and neotraditional food production and gathering activities are close to people's hearts. Inasmuch as we cannot manage resources without being able to control people's use of these resources, it is imperative that traditional systems of resource use be understood and efforts to develop integrated systems of sustainable use involve the people whose resources are being managed.

The topography of the Caroline islands has resulted in a series of natural habitats which filter runoff. Traditional Micronesian systems of agriculture utilized these habitats while maintaining their function. These agricultural systems, as represented on Yap, include taro patch systems, tree gardens and intermittent, multilayer, mixed gardens. Together they make up about 30% of the vegetation, provide a series of ranked foods throughout the year and represent a considerable collection of genetic wealth and horticultural sophistication.

The traditional agriculture system of Yap is characterized as "nature intensive" in contrast to Asian "labor intensive" agriculture and Western "energy, chemical and dollar intensive" agriculture. It takes advantage of natural processes and involves adaptive methods and appropriate timming. This requires a focus of effort and Yapese culture provided for such "technology transfer" through division of labor. The currency of culture was the calorie and energy was conserved. People's use of resources was managed through social stratification, territoriality, resource apportionment, limitations on harvest, effective sanctions and group spirit.

These practices are changing today. Factors having neutral impact on traditional production include land tenure, attitudes toward traditional agriculture, demand for traditional crops, availability of labor and availability of new technologies. Factors inhibiting traditional practices include today's focus on economic development, real problems of production and marketing, institutionalization of problems and lack of an individualized environmental ethic. Problems of motivation and incentive to develope traditional production include the availability of new resources, the clash of caste, the clash of caste, the crises of leadership, the problem of all too quiet dignity, the availability of an easy out, and perceived inconsistencies in U.S. policies. The impact of these changes will be a decrease in self-reliance based on local resources.

Improvement of traditional productivity and sustainability of traditional systems involves the establishment of development guidelines to assure at least the sustainability of a subsistence base and that economic development projects be sustainable. Currently functioning systems must be protected, assessed and enhanced. Relevant new systems may be useful, and a neotraditional environmental ethic must be developed.The traditional knowledge base must be incorporated into development efforts and priority must be placed on the development and support of resident expertiese. If this is done, the United States has an opportunity to help the people of Micronesia develop a neotraditional model of integrated resource management for the Pacific with considerable implications for the rest of the tropical world.

INTRODUCTION:

Traditional food production and resource management systems are present in varying degrees throughout the high islands of Micronesia. In some places, such as Yap, traditional products provide the bulk of food and fiber to the rural sector. In others, such as the Marianas, traditional and neotraditional agriculture and gathering activities provide intermittent but culturally important contributions to the indigenous population.

Given variations in habitat, cultures and history, and lack of literature on traditional food and fiber production systems of the islands under consideration, it is not possible to adequately cover specific details of the traditional agricultural systems of each island. Thus after the presentation of a general overview, discussions are focused on Yap where traditional systems of resource use are most diverse and (to the author at least) most apparent.* References are then made to variations or specializations on other islands as appropriate. In order to put traditional agriculture into its environmental and cultural context, the overall system of resource management is considered.

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* Much of what is reported in this paper is original, based on observations over a period of about 35 years in Micronesia, including many years on Guam beginning about 1949, and the last last 17 years on Yap. I am less familiar with the other high islands of Belau, Pohnpei, Truk and Kosrae where the senior author has but visited and studied the vegetation. As a result much of the information in this paper applies to Yap, where it appears however, that traditional food and fibre production systems are today best developed and retained. Work on Yap continues and additional work is needed on the other islands.

Section 1: AN OVERVIEW OF THE ENVIRONMENTAL SETTING AND TRADITIONAL AGRICULTURAL SYSTEMS IN MICRONESIA

The high islands of Micronesia fall into 3 general geological groups: islands of mostly volcanic and basaltic origin (Belau, Yap, Truk, Pohnpei and Kosrae), the mostly coralline islands of Fais, Guam (the southern half of which is volcanic), Rota, Tinian and Saipan; and the young volcanic islands of the northern Marianas, which though high are very small and mostly uninhabited.

Water readily percolates through the raised limestone of the southern Marianas and the native vegetation of these areas includes distinctive forests growing on limestone rock sometimes with little soil. Relatively little appears to be known about pre-contact (pre-Spanish) agriculture in the Marianas. In general, many of the food plants discussed in section II were probably grown traditionally and most are grown today. There may, however, have been two specialties: the first, the use of the cycad _Cycas circinalis_, of the limestone forest habitat, and the second, the possible growing of rice (Solenberger 1967).

In the case of the Caroline islands of Babeldaob (Republic of Belau), Yap, Truk, Pohnpei and Kosrae, correlations may be drawn between environmental conditions and traditional food production systems. These high islands provide for the collection of rainfall and acceleration of flowing water from uplands to lowlands and into the sea. This has resulted in a series of habitat zones where sediments and nutrients carried with this fresh water are filtered out and utilized in a series of biotic communities successively less tolerant of siltation (Falanruw,1980).

The "runoff filtering system" of these islands is shown in figure 1. The force of often torrential rainfall is buffered in highlands by forests, it flows into coastal depressions which function as silt traps, and then into mangroves where sediments are further filtered out , decayed and chemically buffered amid the specialized aerial roots of these marine forests. Silt which gets through the mangroves flows into coastal depressions functioning as a second silt trap,and seagrass meadows then serve to settle out remaining silt. The filtering zone serves to maintain the clarity of lagoon waters for marine life requiring sunlight for photosynthetic activity such as marine flowering plants, symbiotic algae of corals, coralline algae which forms the bulk of the reef flat zone, and phytoplankton. The filtering zone also serves to buffer the impact of waves upon the shoreline of islands.

The terrestrial activities of early inhabitants of Caroline high islands , whether by design, necessity, or both, seem to have modified the vegetation of the runoff filtering system to meet their needs without altering its basic function. Swamp forests and low areas inland of mangroves were converted to taro patches which utilized these silt traps while maintaining their function.

Traditional agricultural activities further inland also produced minimal increases in soil erosion (ibid.). The agricultural "specialties" of the islands of Belau, Truk, Pohnpei and Yap present 4 "strategies" for maintaining the vegetative cover over the soil (fig.1).

Palauan women are well known for their expertise in growing _Colocasia esculenta_ or "kukau" taro and their large island of

Babeldaob is especially rich in habitat suitable for taro patches. Lowland forests are well developed, and the most species diverse in Micronesia (Fosberg 1960). It appears that many areas of these forests were cleared to create taro patches. The former nutrient recycling via fallen leaves from swamp forest trees is today maintained by the addition and mixing in of plant materials to produce the rich muck ideal for the culture of Belau's specialty.

On Truk there is little coastal lowlands and slopes have largely been converted from native forest to coconut-breadfruit agroforest. These forests, produce food while maintaining a cover of trees to protect and stabilize the soil. Trukese have focused on breadfruit and developed numerous varieties (MacKenzie et al 1964). For times when breadfruit is out of season a means of fermenting the fruit so that it can be stored developed.

The island of Pohnpei is high enough to create considerable rainfall and more than 10,000 mm of rain per year are estimated to fall on upper slopes. Removal of vegetative cover under such conditions would result in rapid leaching of nutrients and soil erosion. The Pohnpeian specialty of growing yams (Dioscorea spp.)however, provides for intermittent removal of the canopy. in a diffuse pattern as yams are planted below trees. Depending on the tree species and the amount of sunlight filtering through its leaves, the tree may be injured or killed so that it drops some or all of its leaves as the yam vine grows. Eventually, the yam vine covers the tree. After a series of harvests the tree may recover or else the space is rapidly revegetated to close the canopy.

Yap is subject to dry spells and erratic weather. Here women are the main gardeners. A diverse gardening system has developed incorporating taro patch systems, tree crops, yam and mixed multilayered gardens alternated with secondary tree cover, and at least today, some open canopy cultivation of sweet potatoes. This system of food production is discussed in greater detail in section II.

Guam and the Western Caroline islands of Yap and Belau are subject to a monsoon like weather pattern with dry spells often occurring between December and June. On the rolling volcanic hills of these islands there exists an extensive vegetation type which is partly native and partly man-made: the "savanna grassland"*1. A number of endemic plants can be found in these areas and it is believed that the habitat has long been present (Fosberg, 1960). The extent of openland however, appears to have been increased by repeated burning which has selected against trees and favored the growth of fast maturing herbaceous vegetation. Repeated burning of this fire prone vegetation has resulted in soil degradation leaving heavy clay soils of decreased value for food production. Such open areas are not as extensive in the eastern Carolines, and where they exist on Pohnpei, the vegetation is largely Gleichenia fern. The rehabilitation of these degraded lands is a great challenge for the future.

Figure 1. Relationship between topography, habitats, and traditional food and fiber production on high islands of the Carolines.

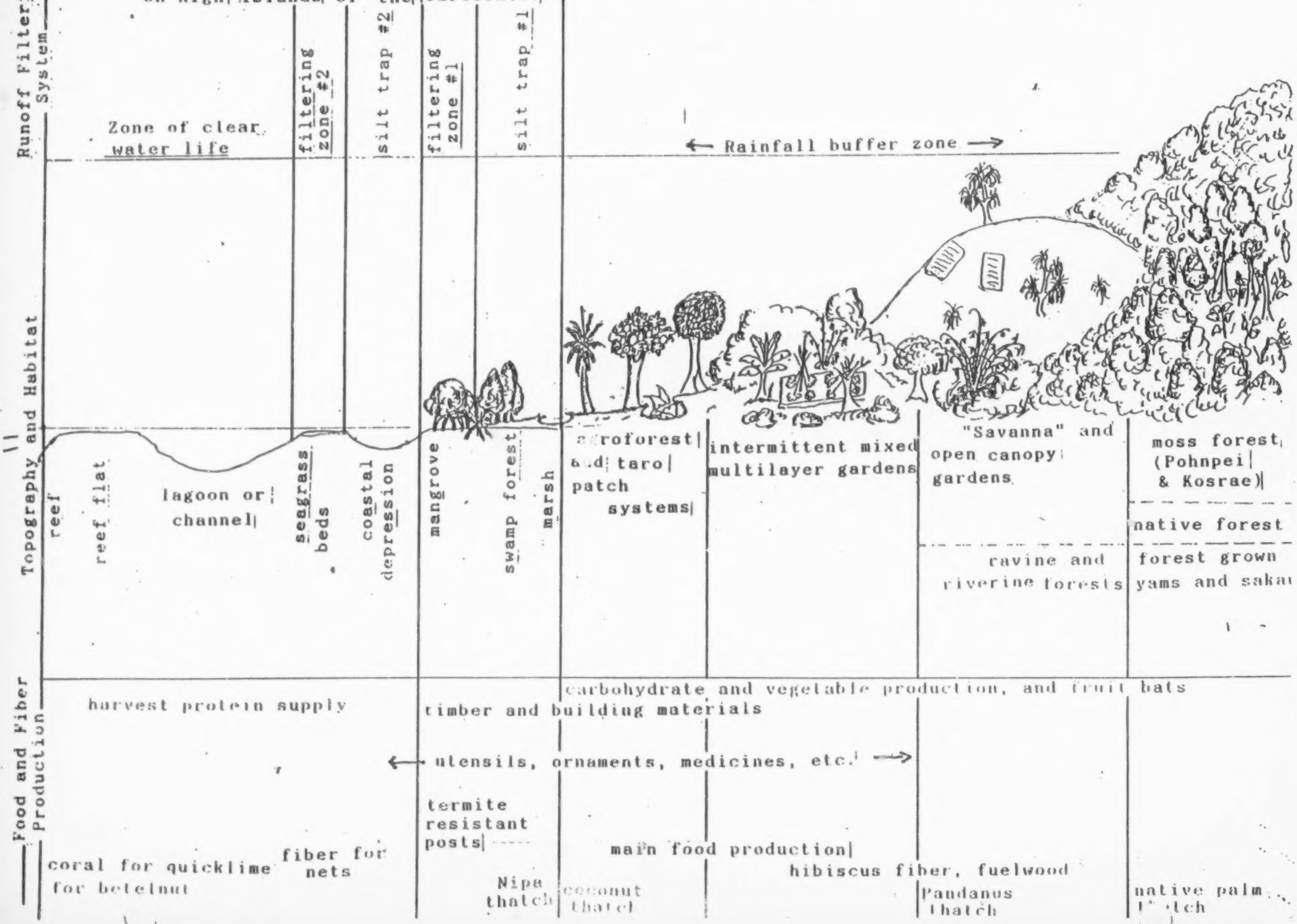

Runoff Filtering System
Zone of clear water life
filtering zone #2
silt trap #2
filtering zone #1
silt trap #1
← Rainfall buffer zone →
Topography and Habitat
reef
reef flat
lagoon or channel
seagrass beds
coastal depression
mangrove
swamp forest
marsh
agroforest and taro patch systems
intermittent mixed multilayer gardens
"Savanna" and open canopy gardens
ravine and riverine forests
moss forest (Pohnpei & Kosrae)
native forest
forest grown yams and sakau
Food and Fiber Production
harvest protein supply
carbohydrate and vegetable production, and fruit bats
timber and building materials
← utensils, ornaments, medicines, etc. →
termite resistant posts
main food production
hibiscus fiber, fuelwood
coral for quicklime for betelnut
fiber for nets
Nipa thatch
coconut thatch
Pandanus thatch
native palm thatch

Fig.1 cont.

CAROLINE ISLAND "SPECIALTIES"

Belau Extensive and Beautiful Marine Areas	extensive & most species rich mangrove & riverine & swamp forest	limited agroforest	limited	extensive savanna - - - - - - open canopy production of cassava	native forest rich in species & endemics
Yap Limited to moderate nearshore marine resources	developed mangroves, little swamp forest	very well developed taro patch & agroforest systems the latter species rich	well developed intermittent, multilayer gardening systems	extensive savanna - - - - - - some open canopy sweet potato production	limited native forest
Truk Extensive but damaged marine areas	limited	extensive but species poor agroforests	limited		limited remnant native forest (except for Tol) with high rate of endemism
Pohnpei Moderate to good marine areas	extensive mangrove, some swamp forest	fairly extensive agroforest	see forest column	some savanna fernlands - - - - - - some production of pepper	traditional yam & sakau production Well developed native forest &
Kosrae Limited to moderate marine areas	mangrove mostly inside costal strand, some quite tall; well developed & extensive swamp forest	moderate to developed agroforest, esp. citrus		very little	unique moss forest with high rate of endimism important as watershed (both Pohnpei & Kosrae

Section II. THE CAST OF TRADITIONAL AGRICULTURAL SYSTEMS

The agricultural "specialties" described in section I can be found in varying degrees throughout the area under discussion. Species involved are described in Barrau (1961), Sproat (undated) and Soucie (1981). The discussion below focuses on *systems* of production.

2.A. Taro Patch Systems

Species and varieties of food plants in the family Araceae, generally thought of as "taro", can be grown in wet or relatively dryland situations. The latter are dealt with in the section on mixed gardening. The culture of wetland taro generally involves the preparation of taro patches and the management of water and are considered here as a distinct system.

Sites chosen (in most cases by ancestors of the present generation) for taro patches are mostly marshy lowland areas such as exist in swamp forests just inland of mangroves. These are deepened as needed, and water is generally directed to flow through the taro patch. There are 2 main kinds of taro patches: those in which *Colocasia esculenta* (L.) Schott ("true taro") is grown, and those used for the production of *Cyrtosperma chamissonis* (Schott) Merr. These two major kinds of taro are sometimes grown together but the cultural methods are somewhat different.

Belau appears to have the best developed cultural methods for *Colocasia* . There the development of a taro patch involves the clearing of a suitable area, in many or perhaps most instances, the site of a previously worked patch. The area may be drained and soil is dug up and green manure laid down and covered with soil. The patch is then thoroughly mixed and "cultured" to obtain a nutrient rich muck of desired consistency. Planting material consists of small corms or the tops of corms which have previously been harvested and allowed to dry some. These are planted in depressions and soil is mounded about developing corms so that they will grow large. There is a considerable body of expertise involved in the choice of green manures , choice of variety suitable for the site and intended use, management of water, and planting and tending the plant in order to obtain the desired shape, size and consistency of the corm. A number of cultural taboos such as not eating prior to working in the taro patch and incantations to help the taro grow may be involved.

At some point in the past, probably during Spanish and German administrations, various taro diseases including *Phytophthora* were introduced. These diseases have been devastating to taro crops in parts of the Pacific as Bougainville and the Manus islands. Despite their presence in Micronesia, taro culture has continued. This may be due to the absence of the complete spectrum of taro diseases (in some cases diseases are not expressed or not lethal until more than one pathogen is present), or because of the genetic variability of taro in Micronesia resulting in disease buffering or due to the development of appropriate cultural practices by Micronesians. *2

Colocasia is harvested from 6 months to a year after it is planted depending on the variety and other conditions. The harvested product will not keep long, so only as much as can be consumed is harvested. The supply is stretched over a longer period by maintaining the cooked taro for some days. A continuous supply is provided by successive plantings throughout the year.

Once a Colocasia patch has been established, is is not necessary to repeat the process of moving soil around and adding large amounts of green manure until the quality of the growing media declines.

Colocasia is highly esteemed in Belau, Yap and Kosrae especially, and good quality corms are important for social occasions. In order to provide for this, Palauan taro patches are divided into sections in which the intensity of management is related to the end product: a fairly intensive worked area to provide for the families caloric needs, a section with optimal conditions for producing especially high quality corms for special people and special occassions, and sections which are worked less intensively for reserve supplies. This managment is discussed by Sugiura (1942). McKnight and Obak (1960) seem to draw on the technical content of Sugiura, and they and McCutcheon (undated), dwell on the anthropological aspects of kukau culture and its decline.

Cyrtosperma chamissonis is the main taro in Yap. It's culture is not as labor intensive as that of Colocasia and appears to rely more on the natural transport of nutrients in water directed through the taro patch. Green manure is not generally added, and cultural methods involve the periodic removal of fallen vegetative material and debris in order to maintain the flow of water through the system. Expertise is required in matching varieties to habitat and choosing the proper time to harvest to obtain a corm of suitable consistency. The harvested corm does not keep well and therefor only as much taro as will be consumed is harvested at one time. The ideal on Yap is for "lak'" to be harvested and cooked fresh each day. In actual practice at least nowadays in my experience, a whole basket weighting up to about 40 pounds is harvested and cooked over a period of 2-4 days.*3

Replanting of *Cyrtosperma* is done at the same time as harvesting, generally utilizing the smaller sucker corms that are produced about a large "mother corm", and there is no hiatus required to recondition and replant the patch. The corms take longer to grow, reaching harvesting size in from 1-3 years, but they do not require as intensive care as *Colocasia* , and may be left in the taro patch indefinitly. The production of corms for family use as well as large corms for presentation may occur in the same taro patch. Seperate taro patches are however maintained for elder men and these are worked by older women or men.

The corm of *Cyrtosperma* is generally more fiberous and firm than that of *Colocasia* and the quality of the corm is related to the taro patch from which it came. *Cyrtosperma* is more shade tolerent than *Colocasia*, and is thus more compatible with tree culture, and is an integral part of the agroforestry system of Yap.

Taro patches are generally managed on an individual or family basis, the individual taro patch having been handed down from one generation to the next. Special taro patches are entrusted only to appropriate older women or men. Where taro patch habitat is extensive, the area is subdivided into separately tended subplots.

Because of the intensive culture required, and the fact that it cannot be left in the ground too long beyound maturity, the scale of taro production on Belau is related to family needs for food to eat and for contributions on appropriate occassions. Because it requires less intensive care, and a longer period of development, *Cyrtosperma* culture on Yap is more extensive.

Taro patch culture is also especially important in Kosrae where there is extensive rich habitat in some swamp areas. It is also present in Truk and Pohnpei.

2.B. Tree Gardens

One of the specialties of Micronesian agriculture are tree gardens with a high proportion of food producing species. In its simplest form such gardens consist of a mix of coconut (*Cocos nucifera* L.) and breadfruit (*Artocarpus* spp.). with occasional other trees. Such areas are extensive in Truk.

On Yap the mix of agroforest species also includes betel nut (*Areca catechu* L.),*Inocarpus fagifer* (Park.) Fosb., a tree in the bean family which produces large nutritious seed; a wide variety of bananas (*Musa* spp.), mangoes (*Mangifera indica* L.) many varieties of *Citrus* spp. including sweet and sour oranges, lemons, limes, lemon-limes, and pomelos. Also common are: soursap and other species of *Annona* , *Crataeva speciosa*, a small tree with a vegetable-like fruit; starfruit and pickles (*Averrhoa* spp.); *Pangium edule*, which produces delicious if strong smelling fruit; cacao (*Theobroma cacao* L.),papayas (*Carica papaya* L.); *Eugenia* spp. "apples"; guava (*Psidium guajava* L.); *Spondias* spp. which provides leaves for flavoring fish soup and fruit for drinks, and other food trees mixed with timber and wild species of trees and with an understory of shrubs and herbs useful for food, fiber, medicine , condiments, ornamentation, etc.

Such tree gardens on Yap involve about 50 species of food trees. Within the species that have long been cultivated by Yapese there are numerous locally recognized varieties. There are, for example: 21 names for coconut varieties,28 names for breadfruit and 37 names for varieties of bananas! Such tree gardens represent a considerable collection of genetic wealth.

Tree gardens were developed by ancestors of the present generation. The likely process on Yap was the planting of food and other useful trees about homesteads, and in the drained areas created by the excavation of taro patches and construction of paths between homes and villages. Fruit bats aided with seed dispersal in some cases. Backyard and pathside tree gardens became confluent and today make up about 27% of Yap's vegetation (Fig.2) (Falanruw et al in prep.).

Tree gardens are relatively self-fertilizing via the recycling of fallen leaves as in a wild forest. They are maintained largely by the pruning activities of their owners who select for desired trees by cutting or girdling those trees that are not desired, and improving growing conditions for those trees which are desired. Many of the trees propagate themselves via root growth (as with breadfruit), or seed. People preserve desired volunteers as well as planting desired varieties and species. Once such tree gardens are established, relatively little input is required for their maintenance.

Animals maintained in village tree gardens on Yap include penned or tethered pigs and chickens about Yapese households and feral chickens in the bush. Fruit bats may forage in these areas at night. (Footnote number 12 relates to feral animals.)

To a lesser extent, tree gardens are found throughout the high islands of Micronesia, especially on Pohnpei and Kosrae. The pattern of agriculture in prewar Guam involved residence in villages with outlying farms known as "lanchos" or "ranches" where families raised livestock, fruits and vegetables. About 50% of these areas were made up of tree species (Karolle 1978).

2.C. Intermittent Gardens

Areas about and generally inland of villages are used for gardens of yams and other crops generally grown in mixed, multilayered culture and alternated with a fallow period in which secondary growth develops.

Sites chosen for such gardens are relatively well drainned areas of secondary vegetation often the sites of previous gardens, within the land available to the family, or land which may be borrowed for such use. Four general types of areas are typical:

1) Areas on the outskirts of villages which have become covered with a characteristic set of small secondary trees and often with an understory of ferns. Such areas are generally the site of a previous garden, and are indicated as weedy secondary vegetation in Fig.2.

2) Areas on the outskirts of villages which are covered with secondary forest consisting of a characteristic set of tree species.

3) Areas on the outskirts of villages which are covered with a mix of secondary vegetation and 2 species of Bamboo.

4) Areas within villages where neat raised beds are constructed and bamboo poles brought in to build a series of neat yam trellises.

The choice of site is determined by a number of factors foremost of which is the intensity of the dry season. An extended dry season is required to be able to burn intensively enough to kill larger trees. Other factors include the amount of land,energy, help and need a woman or family has. The soil in areas of secondary forest are richest and there is a nearby supply of poles for trellises, so such areas are preferable when it is possible to undertake and accomplish the task. Site 2 type areas are indicated as low and secondary forest with weedy vegetation (Fig.2). During years with shorter dry seasons and when land or a women's time and energy are limited, site 1 type areas are generally used. Site 3 areas have resulted from the planting of bamboo in earlier days when the large and small bamboo were needed in house construction, and the large bamboo was utilized to build rafts, the most common type of water transport. Now that rafts are used less, other building materials are available, and the style of house built by young couples less traditional, areas of bamboo are often burnt to be used as gardens.

Site 4 type areas are generally the work of a group of women growing yams to present on a special occassion. Such gardens are limited in size, more labor intensive, and do not generally have a variety of other crops planted in the same site, at least the first year.

The first step in making a garden is to open a "skylight" in the canopy. This is done by clearing herbaceous vegetation and piling it about trees and burning the vegetation and bases of the trees or else girdling the trees or both as needed. In type 1 areas, the canopy is often removed gradually so that young plantings are shaded the first part of their lives. The presence of standing logs and surrounding vegetation makes this less necessary in type 2 & 3 areas.

The major crop grown in such gardens are yams of the genus Dioscorea. There are at least 6 species of Dioscorea recorded from Yap. Defngin (1964) lists some 34 Yapese names for locally recognized varieties of yams on Yap. Material used for planting yams are the tops of tubers which have been perviously harvested and utilized, as well as small whole yams. Some species produce seed but this is not used. There is a fair amount of expertiese and experience involved in the preparation of yam holes and planting of yams, including choice of varieties for the site and microhabitat, and growing the plant to produce desired sizes and shapes of tubers.

Dried yam cuttings are placed in prepared holes and mounds and well mulched with dried vegetation. They are provided with trellises of several general types. In type 1 and 2 areas these are generally poles, often of bamboo, leading to trees which will allow the vines to grow up into the sunlight and produce large tubers. In areas rich in bamboo, trellises consist of tall "teepees" of 3 or more poles tied together at the top. A border of fallen logs is often formed about the yam plantings and mulch piled within this area.

Yam vines generally grow for about 8-11 months and then begin to wither. When this happens they are harvested, generally about October to March (Falanruw In YINS 1980, 1982, 1983). Planting and harvest times vary with the onset and end of the rainy season which can vary considerably (Fig.3). Varieties of D. esculenta (Lour.) Burk. are generally harvested first. Next come the many varieties of D. alata L. There is no definite planting and harvesting time for D. nummularia Lam. The tubers of some varieties may be left to grow another year so that they become bigger and others may be left to provide a reserve food or "seed" supply. Yam tubers store well, and if well cared for can be stored for up to 2 years if the sprout is continually removed. Most varieties of Yams are well esteemed and make good presentations.

At the time that yams are planted- in the choicest microhabitat, the rest of the garden area is filled in with a mix of other crops, generally in a predictable succession. The first and most common of these are pumpkins (Cucurbita spp.) and wax gourds, (Benicasa hispida (Thunb.) Cogn. which grow fast in the ash fertilizer and form a protective layer of vegetation over the soil. They produce a fast crop and often die back by the time the yams and other crops have made their major vegatative growth. Sweet potato vines may be planted in raised mounds, though they are more often planted in open areas.

Pineapples and sugar cane may be planted in suitable areas. Other crops include Xanthosoma taro, and perhaps Colocasia, if the area or part of it, is moist enough . Banana trees may also be planted, and weeds that are cleared from the garden piled about the banana trees as mulch. Papaya trees generally come up voluntarily in the garden and are left for their fruit. Today the bush spinach Abelmoschus manihot is often planted, and sometimes winged beans and occassionally Cnidoscolus chayamana. Passion fruit and luffa vines may grow, generally voluntarily or from old plantings, in the area. Sometimes a few fruit trees such as limon-limes ,soursap, and Averrhoa spp. from nearby agroforests may be present.

These crops grow rapidly so that a multistoried canopy of leaves is formed by the time the main rains come. The intermediate crops such as pumpkins, wax gourds, bush spinach, taros etc. are harvested as they mature and then at the end of the growing season, the yams are harvested. The garden may then be replanted for another year if the soil is still fertile, otherwise it is only sporadically tended to harvest longer term crops, and gradually abandoned. Site 2 gardens are generally utilized for more than a year as the soil is more fertile. Such gardens however are seldom used for more than 3 years.

After gardens are abandoned, they go through a series of successional stages as the wild canopy reforms. First they are invaded by herbaceous weeds. These are followed by more woody species, mostly consisting of the set of species found in site 1 areas. If the area is not disturbed, the species characteristic of site 2 will, with time, develop in the area. The agency of seed dispersal of such secondary vegetation are largely birds, especially bridled white-eyes *Zosterops conspicillatus* for *Macaranga* and the Micronesian starling *Aplonis opaca* and fruit bats *Pteropus mariannus yapensis* for the bigger forest trees (Falanruw in prep.).

The mixed culture of yams and other family food crops is practiced in other high islands, especially Pohnpei, where however there is another more intensive style of producing yams especially for presentation.

Yams are held in high esteem on Pohnpei, where men can gain status in the traditional system by presenting especially large or especially old yams at social occassions. Another crop of similar importance is sakau, *Piper methysticum*. These socially important crops are grown by men in relatively secret forest plots away from residential areas. There is a considerable body of expertiese and experienced involved in the preparation of planting area and tending of yam vines to produce large tubers.

In general the methods used in Pohnpei are the preparation of special holes below trees, and the trainning of the vines into the canopy. This generally involves providing a string, often of *Hibuscus* bark, which is tied to a stone and thrown up to the first branches of the tree trellis which may be injured or killed so that it drops part or all of its leaves. When the yam vines reach the first branches, they may be provided with more strings to higher branches of the tree. If all goes well, the vine grows to cover the tree and form a canopy similar to that of the former leaves of the tree.

Other sites used for growing yams are areas of secondary vegetation which, on Pohnpei often consist of almost pure stands of *Hibiscus tiliaceus*. These trees are killed and utilized as trellises. *Piper methysticum* cuttings are also planted in secondary vegetation and forests where the canopy is gradually removed. Nicely enough, the material for strings for trainning yam vines, and the fiber used for squeezing the juice from pounded sakau roots is made from the bark of the hibiscus tree which comes up as secondary growth.

2.D. Open Canopy Agriculture

Crops grown in openland areas include sweet potatoes, cassava, and vegetable gardens, in order of probable introduction.

Sweet potatoes were probably introduced to Yap by the

Spanish. There appears to be no Yapese name for sweet potatoes which are on Yap called by varients on the Mexican/Indian name, as "camot", "camotee", etc. Elders talk of the ranking of Yap's traditional foods in terms of their presentation value. Colocasia is highest, along with Cyrtosperma ,then a series of Dioscorea followed by breadfruit and bu'oy nuts. Bananas were in a seperate class of foods to be provided to workers rather than as prestige presentations. It is said that in the past people ate foods such as wild figs, arrowroot (Tacca spp.), aerial tubers of Discorea and the smelly fruit of Morinda citrifolia and Crataeva speciosa in order to save the better foods for prestiege presentation. Sweet potatoes are not mentioned, and even today they are not ranked for their prestiege in presentation (though they are often today given in food gifts among family.) Cassava may have been introduced to Yap during German time when it was brought back by men involved in phosphate mining in Palau (Falanruw , S. pers. communication). Even today it is not considered very highly, though it is grown increasingly as a result of the Palauan influence on Yap, and local limitations of soil to support crops other than cassava.

The making of sweet potato gardens involves the construction or, most generally reconditioning of drained garden beds. This is often done by cooperative groups of women who first cut or burn the vegetation on the site, and pile the debris on the garden area, sometimes adding additional mulch including washed up seagrass. Ditches are then dug or deepened around the garden bed and the soil piled on top of the mulch. Vegetation included with clumps of soil dug from the drainage ditches is placed roots up, below the soil. The result is drainage of the garden bed, supression of weeds and development of a "sandwich" of soil, mulch, soil. Cuttings of healthy vines of selected varieties of sweet potatoes are planted in this bed, generally during the rainy season.

Cassava is not an important crop on Yap. It has come to be very important however in Belau. There it is cultivated by the preparation of raised rows into which cuttings from the lower portion of selected varieties are inserted. Rechesengel (1965) lists some 31 Palauan names for varieties of "thiogang" (cassava), commonly known in Palauan English as "tapioca."

The most persistent efforts of the government departments of agriculture , at least during the American Administration, appears to have been the encouragement of open canopy vegetable gardens. The making of such gardens involves crops such as chinese cabbage, green peppers, tomatoes, corn, etc. and western techniques of clean gardening, utilizing fertilizers, pesticides, etc. There have been some examples of successful operations but most have not lasted long. Vegetable gardens on Yap have been rapidly invaded by weedy growth including noxious weeds such as the spiny introduced Mimosa invisa which is difficult to clear. Because of the high inputs per output and problems of soil degradation, Western methods of agriculture have not been successful in the humid tropics (Vermeer 1973). Nontheless, outside advisors whose visits to Yap are generally limited to the few days between plane flights, keep recommending such technology and outside funding continues to be made available for such efforts.

The degree of environmental impact of the gardening systems described above varies. The incidence of soil erosion is probably greatest in Western type vegetable gardens where the soil must be made very friable, and the vegetables growth does not provide adequate protection against heavy rainfall or invasion by weeds. Sweet potato and Cassava gardens do not appear to be very sustainable. Today there are an increasing number of pests of sweet potatoes including rats and insects (personal experience and reports of local women and agricultural extension worker Paam.) The repeated burning and depletion of nutrients and soil texture associated with cassava culture results in soil degradation.

The environmental impact of the more traditional multilayered mixed gardens varies with the extensiveness and intensity of burning. It is said that in the past women were very careful about chosing the garden area and about controlling burning so that only the area actually needed was burnt. Whatever the case in the past, today more forest and secondary vegetation is burnt than is well utilized. Part of this is due to careless gardeners, and part to outright arson. Youth are largely blamed for starting grassland fires but even adults, some of them deranged, have been known to start wildland fires. There appears to be little concern or instinct for controlling fires that have gotten out of hand.*4 The local fire department responds only when residences, telephone poles, etc. are endangered. Other than on Guam, efforts to inform the Public of the deletarious effects of frequent extensive burning have been limited (Fig.4). The topic is currently being integrated into the 7th and 8th grade science curriculum on Yap, and was included in Fish and Wildlife sponsered teacher workshops the summer of

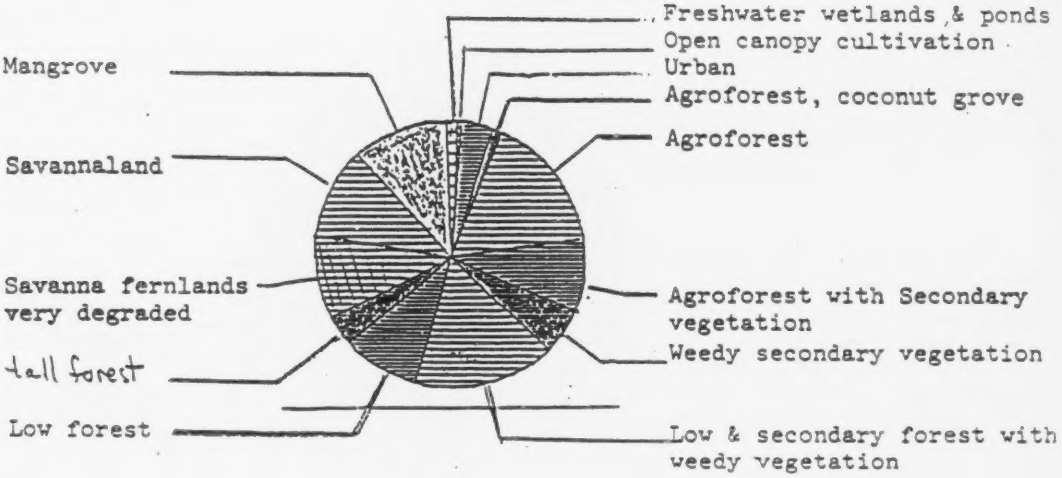
1984 (YINS, 1984). The U.S. Forest Service sponsered a workshop in 1985 which delt with investigating and controlling fires. This workshop was attended by firefighters from Guam and foresters from Guam, the Northern Marianas, Pohnpei and Truk.

The situation which can be expected to result from too many attempts at open canopy gardening, and too frequent burning of garden lands with too short fallow periods left between gardens is a decrease in site 2 type forest fallow reserves, followed by utilization of site 1 type areas to their exhaustion, followed by a switch to open canopy gardening and degradation of the soil to the condition of that found in the Pandanus grasslands. That all of these habitats have been utilized at one time for gardening is evident in the presence of old garden beds.

The rate, and extent of soil degradation on Yap and Belau is worthy of investigation. The impact of past Japanese agricultural efforts should be investigated as well as geological factors, impact of winds, etc. The author has observed that practically all areas of Pandanus grassland on Yap have been burnt at least twice (during the severe droughts of 1973 and 1982-83), and most many more times in the last 14 years. Many of these areas have trees, as would be found in site 1 type areas, which persist in a shrub-like stunted state because they are burnt so often. It would be helpful to see how long it would take for such areas to return to a site 1 condition if burning were prevented. The end result of prolonged degradation of soils would seem to be Gleichenia fernlands.

Figure 2 shows the approximate percentates of the vegetation types mentioned above. Figure 3 shows how Yap's diversified food production system provides food throughout the year. Note that the production of yams is counterpoint to the production of breadfruit. The tree gardens and taro patch systems offer stability and the intermittent gardens offer variety, resilience and a means of adapting to each year's weather conditions.

Figure 2. Main Categories of Vegetation on Yap



Source: Draft Vegetation Map of Yap (Falanruw et al in prep., U.S. Forest Service)

Figure 3. Seasons and Seasonal Produce on Yap

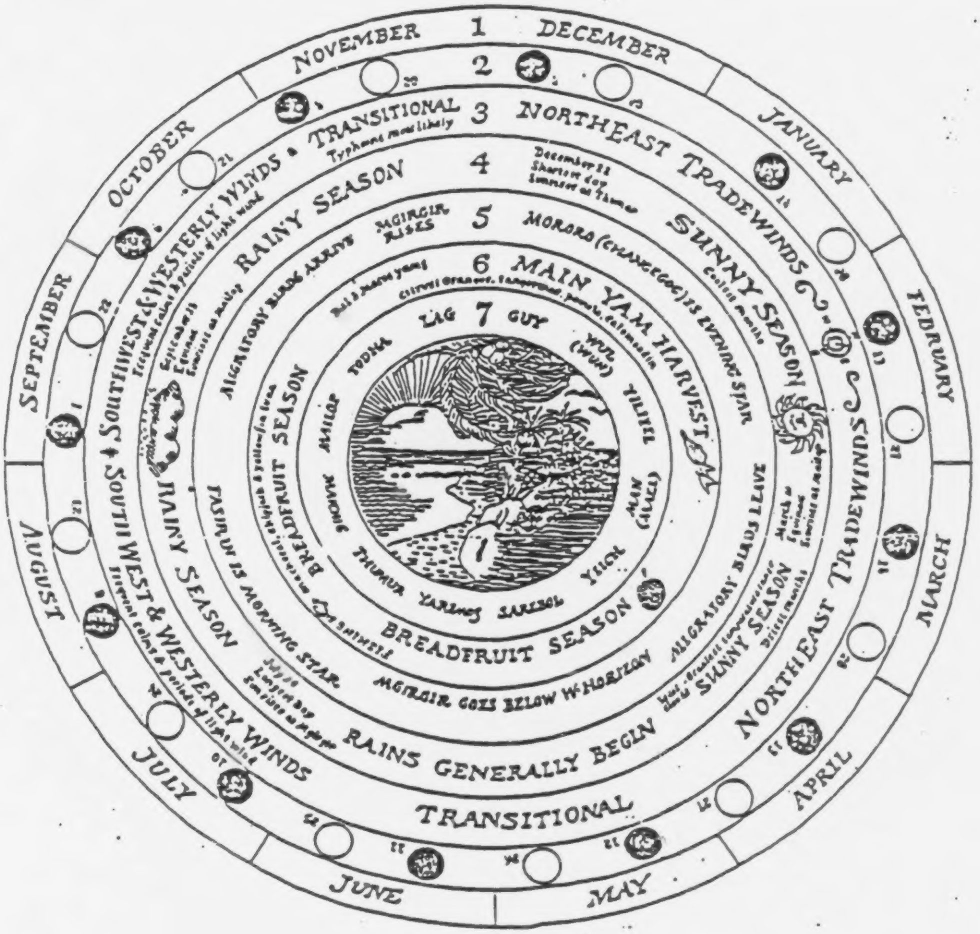

NOVEMBER
1
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
2
3
TRANSITIONAL
Typhoons most likely
NORTHEAST TRADEWINDS
SUNNY SEASON
Coolest months
NORTHEAST TRADEWINDS
SUNNY SEASON
Driest months
TRANSITIONAL
SOUTHWEST & WESTERLY WINDS
Frequent calms & periods of light wind
SOUTHWEST & WESTERLY WINDS
Frequent calms & periods of light wind
4
December 22
Shortest day
Sunset at Tamae
RAINY SEASON
RAINS GENERALLY BEGIN
RAINY SEASON
September 23
Equinox
Sunset at Mailog
March 20
Equinox
Sunset at Mailog
June 21
Longest day
Sunset at Magpag
5
MGIRGIR RISES
MORORO (CHANGEGOG) IS EVENING STAR
MIGRATORY BIRDS LEAVE
MGIRGIR GOES BELOW W-HORIZON
TASIRUW IS MORNING STAR
MIGRATORY BIRDS ARRIVE
6
MAIN YAM HARVEST
BREADFRUIT SEASON
BREADFRUIT SEASON
Citrus: oranges, tangerines, pomelo, calamondin
7
LAG
GUY
WUL (WUW)
TILIFEL
MAN (AWEL)
YUGH
SARISOL
YARMOG
THUMUR
MAGONG
MAILOP
TODHA

Figure 1

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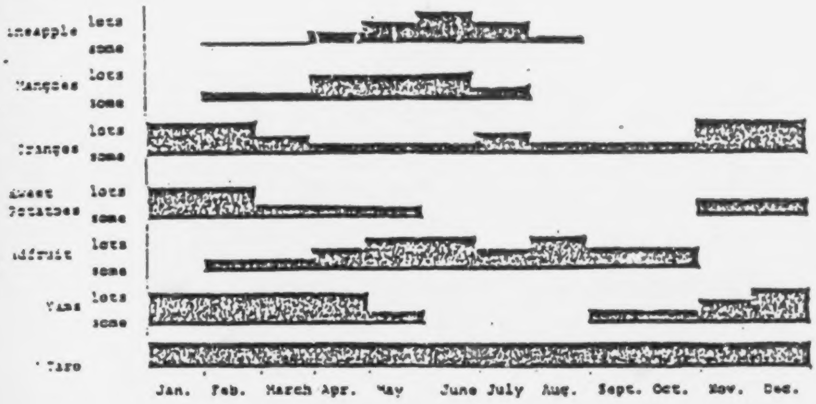
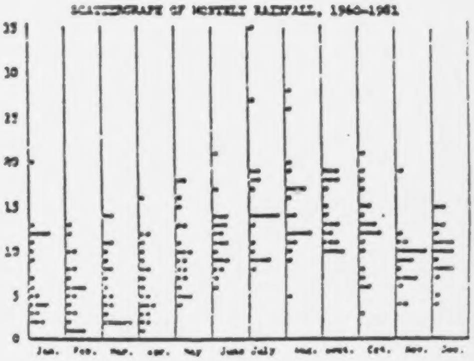




Source: Yap Almanac Calendars 1981 & 1983. published by the Yap Institute of Natural Science, Yap.

2.E. "Lanchos" and Backyard Gardens

Traditional agricultural activities in the Marianas are not well documented. There is some question as to whether rice was grown in precontact times. If so, the Marianas would be the furthest oceanic outlier where rice was traditionally grown (Solenberger op cit.)It seems likely that the original inhabitants of the Marianas also ate foods such as taro and breadfruit and *Dioscorea* as are eaten on other high islands of Micronesia. A number of probable traditional foods persist in the extensive stands of *Cycas circinalis* and feral or wild *Dioscorea*. The seeded breadfruit *Artocarpus mariannensis* Trecul. is a common component of a subtype of limestone forest. The wild taro *Alocasia macrorrhiza* (L.) G. Don was formerly very common along Guam's roads. It's decline may be related to the lowering of Guam's water table (personal observation).

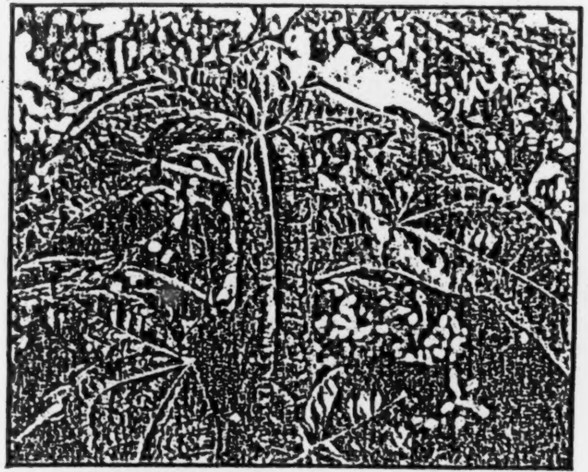
The neotraditional agriculture system of the Marianas seems to have been the development of "lanchos" or "ranches" where food was grown by people who resided in village areas. Such ranches were common up to the late 1950's at least. They were generally located in more rural wooded areas and consisted of a simply built cooking and sleeping house surrounded by food trees, chickens, pigs and gardens. In the past, some member of the family, generally resided at the "ranch" to look after the chickens and pigs, and perhaps a carabao. Other family members would go to the ranch, especially on week-ends to tend the gardens, gather produce, go hunting in nearby forests for deer and fruit bats, or to collect cycad nuts or wild yams. Some produce was consumed at the ranch, often in a picnic type atmosphere and the surplus was brought to the village residence for use during the week or for

Fig. 5. Source: Yap Almanac Calendar, 1981

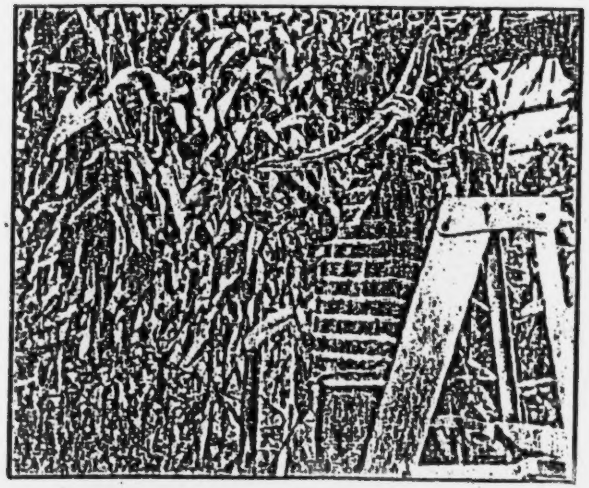
SOME EASY TO GROW VEGETABLES

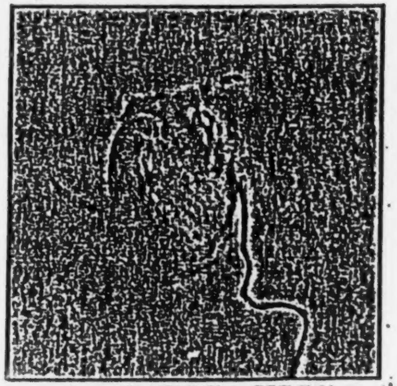
Wingbeans

This vegetable from Southeast Asia and New Guinea has recently been "discovered" by scientists excited about its high protein content and many reccomendations are being made about it. It has been on Guam a long time where it is called "sigidillas". It has been on Yap at least 9 years-evidence that good things travel fast among just plain folks even without "outside experts".
The plant is grown from seed and requires a strong trellis if you are growing it for the pods. Its roots bear nitrogen fixing nodules so it is also good for the soil. The young pods can be eaten whole, raw or cooked. They should be harvested while still tender, and are good raw sliced and served with onions, lemon juice, soy sauce and peppers like a salad; or boiled in soups. The leaves, flowers and tubers can also be eaten. Mature seeds require long cooking like other dry beans and are as high in protein as soy beans. There are many varieties of wingbeans, some grown mainly for their pods, and others for the tubers.



Abelmoschus manihot





Ikemas

This vine originally came from Mexico where it has the name Jicamas. It has travelled around, probably with help from the Spanish Galleons that used to sail from Mexico to the Phi ippines with a stop at Guam. On Guam the plant is often called "Sinkemas". It is in the bean family but produces a tuber lil a sweet potato. It can be grow from seed or from a sprouted tuber like yams. Plant it in soft soil and make a trellis for it to climb. The tubers can be harvested in 3-4 months when they are sweet and crunchy. Later they become bigger but are fibrous. The tuber can be eaten raw-children especially like it this way. It can also be made into pickles and used in chopsuey. The seed pods are sometimes eaten when young but are poisonous when old.

"The greatest fine art of the future will be the making of a comfortable living from a small piece of land."
Abraham Lincoln

Fig. 5 Continued

CHAYA

Chaya, whose scientific name is Cnidoscolus chayamansa is an ornamental shrub whose young shoots and tender leaves can be cooked and eaten like spinach. It is relatively new on Yap but has been on Guam some time where it is called "kadagan". The plant is grown from stem cuttings and it can tolerate heavy rainfall and also drought, and produce edible greenery in 2-3 months. Like a number of other greens, the leaves are toxic when raw, and must be cooked. The plant also has tiny stinging hairs on the leaves and stems, but these are destroyed by heating. To prepare the plant, it is good to steam the newly harvested young shoots and then peel off the tough skin- as is done in preparing taro leaves. Chaya is good boiled, then cut into thin strips and served with lemonjuice, onions, soy sauce and pepper. If peeled, boiled, and then cooled and served with mayonaise, the young shoots almost substitute for asparagus spears. It is good in soups too.

Bush Spinach

Bush Spixach

This plant is common in many parts of the Pacific, especially Melanesia, but is relatively new to Micronesia. It has a number of local names. The scientific name is Abelmoschus manihot. It is from the same family as okra. The plant is easy to grow from cuttings, and grows fast. The whole top can be cut off and the base will sprout again. It is a very nutritious vegetable. The young leaves can be eaten when cooked similar to kangkong. It can be cut up and fried with onions and sardenes, or steamed. It is delicious cooked with coconut milk as follows: Fry some pig fat or bacon with onions until they smell good, add cut up mbele (the Fijian name), and some water. Cook a little longer, then add coconut milk and simmer a bit longer. It can also be combined with chaya stems.

fiestas.

Ranches are much harder to find in the present day Marianas where population increases, division of family lands, economic developments, food stamp programs, etc. result in competitive uses for land and decreases the need to raise one's own food. Fresh local produce remains important for fiestas however, and is reflected in poaching of deer and fruit bats and the importation of traditional foods.

Given Guam's problem of frequent storms and typhoons and apparent desire to become a financial, travel, etc. center, economists would probably argue that traditional food production is not important. Such production does result in import substitution but its main importance is that it is the main expression of Chamorro culture (personal observation), and dear to th people of Guam and the Northern Marianas. One of the pet projects of the Governor of Guam himself is the development of fruit orchards and gardens on the grounds of the Government mansion.

Section III. TRADITIONAL GATHERING ACTIVITIES

There is a graduated sequence from the production of food and fiber via traditional agriculture to the gathering of wild resources. Some examples of terrestrial resources which are gathered follow.

On Yap *Nipa* palm leaflets are used to make the best quality thatch, and was planted along the inner margins of mangroves for this purpose. Thatch can also be made of coconut fronds and *Pandanus* leaves.

Two types of *Bamboo* were also planted for building rafts and houses. Today when other building materials are available, bamboo is often burnt to make room for gardens. The use of these two building materials is still subject to the consent of their owner.

Fibers used for string, grass skirts for dancing, etc. were obtained from the bark of *Hibiscus tiliaceus* which commonly grow as secondary vegetation in abandoned gardens. Everyday grass skirts were made, depending on age and activity of the wearer, from dried banana leaves, betel nut leaves, and mixes of turmeric, ti, *Policias* and other leaves and ferns. All of these plants have other uses as well and the ferns grow as understory of old garden sites that have reached the stage that they could be used again. The considerable practical horticultural sophistication of Yapese is indicated in fig. 4.

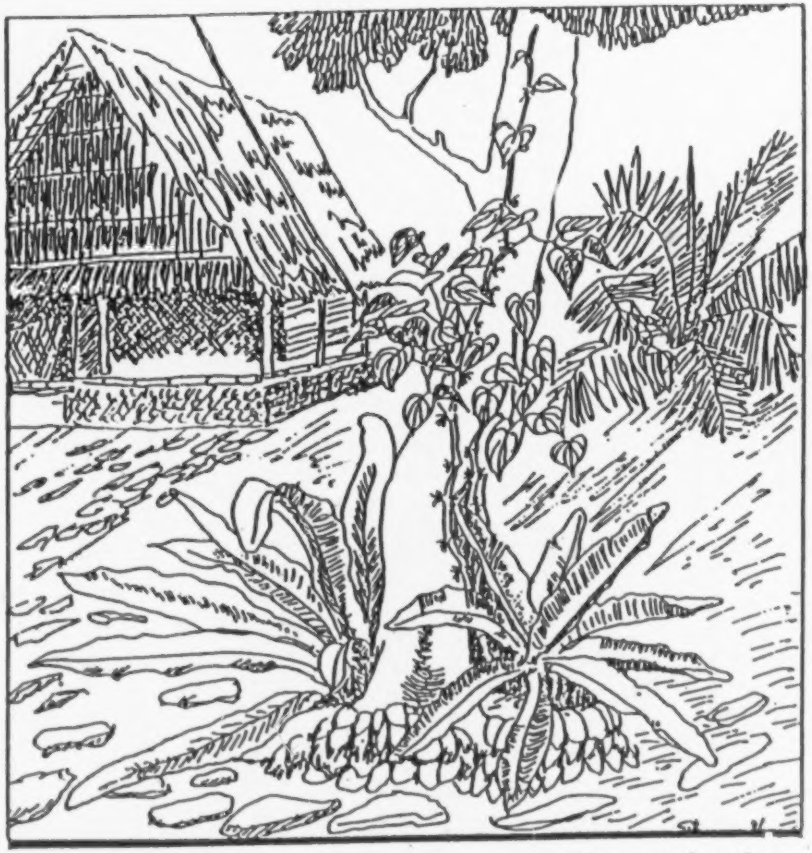
Figure. 4. Yapese Horticulture

A YAPESE GROWING SYSTEM

Though much less celebrated than its voyages for stone money, a notable achievement of Yap is the development of a relatively self-sustaining system of agriculture that orchestrates tree gardens, taro patches and root crops with fallow phases, into a system that produces food year round with a minimum input of energy. The main characteristic of this system is that it is "nature intensive". Rather than rearranging the environment and expending great amounts of energy and chemicals, people's activities are directed to the most effective use of microhabitat and natural phenomena.

Someday "nature intensive food production systems will be as recognized and respected as Asian "labor intensive" and Western energy and chemical intensive methods.

For a nature intensive system to work however, people must be very aware of natural phenomena. Today on Yap there are many distractions such as television to take people's concentration away from natural phenomena and food producing activities.There seems to be a race to see whether Yap will discover the value of some of its own practices before the knowledge and instincts required for those practices dies.



Drawing by Stanley Kenrad : Gabuey in its natural village setting with coconut husk mulch and bird's nest fern to gather humus and moisture.

Gabuey, known to scientists as Piper betle,is an important plant on Yap as it releases alkaloids when chewed with betle nut and lime. The gabuey vine requires a fairly constant supply of moisture to live and Yapese have an ingenious way of growing it so that it makes it through the dry season. It is planted at the base of a tree or other support, coconut husks are piled around, and chath the bird's nest fern, Asplenium nidus, is planted. The fern is an epiphyte and does not compete with the gabuey for soil nutrients. Its leaves though, act like a living funnel to collect moisture and humus to provide a moist environment for the roots of the gabuey, helping it through even severe droughts.Gabuey is also used medcicinally and the chath, besides looking nice, can be used both as medicine and as food. Then when the gabuey leaves are picked,they may be wrapped in chath leaves to keep them fresh! The system is a lovely combination of beauty and function characteristic of Yapese ethnobotanical sophistication.

Source: Yap Almanac Calendar, 1984. published by YINS, Yap

Fuels used in cooking were largely by-products of the food production system: dried husks of mature coconuts (the husks of green nuts were used for rope fiber), husks of Inocarpus nuts and wood from secondary vegetation generally from fallowing garden sites.

Among wild plants gathered are ingredients for Yap's important medicines as well as such specialties as filmy ferns to be incorporated into headresses for a specific dance of a forested municipality.

Like carbohydrates, protein foods were ranked, with turtle placed highest followed by a series of kinds of fish, some of which were considered best for groups such as pregnant women and children, and prohibited to other groups. Turtles if caught, were presented to chiefs as were certain fish. A wide variety of fishing methods, many employing nets and traps were utilized to catch specific fish at appropriate times. The gathering of marine resources is a complex subject treated in greater detail in Falanruw , Falanruw and Moon 1968.

Low on the scale of prestige and in the category of "womens", or "just family" food were crabs, sea urchins etc., which are important foods at times. Many other types of marine life including shellfish and even sea anenomies were gathered for food. In the past, people did not eat fish as much as today and other gathered protein was important for its nutrition if not prestiege. The lowest classes on Yap did not have much if any access to marine resources. The protein source of these groups became fruit bats of the genus Pteropus.

Gathering activities are important elsewhere in Micronesia as well. Fruitbats are harvested in Belau and elsewhere. On

Pohnpei the endemic palms make excellent thatch. Terminalia nuts are harvested in season in Belau to make excellent nut bars. Ti leaves, the sheaths of betel nut ,Pandanus leaves, etc. are used to wrap food for steaming or cooking in underground ovens. Cycad nuts are still gathered on Guam, leached of toxins and prepared into flour, and wild herbs are still gathered for use in medicines.

There are few truly wild areas in Micronesia today. Most are or have been managed to some extent to provide for human needs. The maintainance of an environment meeting the needs of Micronesians involved a complex system of integrated resource management.

Section IV. INTEGRATED RESOURCE MANAGEMENT AND TRADITIONAL PRACTICES HAVING CONSERVATION VALUE

Appendix 1 presents an overview of how resources appear to have been managed by Yap's dense population (estimated at 1,000 / square mile) of the past. This system involved adaptive methods and appropriate timing of activities to take advantage of natural processes and resources. Most of Yap island and Lagoon have been modified into an anthropocentric food production system using methods that mimic and extend natural processes.

Rather than rearrange the environment and expend great amounts of energy, people's activities were directed to the most effective use of microhabitat and natural phenomena. This "technology" is here classified as being "nature intensive", and can be contrasted with what might be classified as, "Asian labour intensive agriculture" and " Western energy, chemical and dollar intensive agriculture.

The "currency" of culture was the calorie and energy was conserved, even in warfare. The main medium of exchange was food. The cultural items well known today as "money" (stone money, shell money, etc), were actually used as means of smoothing social interactions and keeping the peace - both important in energy conservation.

Resources can only be managed if there is a way to regulate people's use of these resources. The social organization of Yap provided for such regulation as a result of social stratification, territoriality, resource apportionment, limitations on harvest, effective sanctions and group spirit (Falanruw, in press, Appendix I).

Many traditional practices had conservation value. These resulted however, from technological limitations of natural materials, taboos and religious beliefs, territoriality, inequality of people, etc.(ibid). These factors can be so intertwined with lifestyle and culture that they are difficult to isolate and evaluate as conservation practices per se. They do, however, have implications for resource management today.

Section V. IMPLICATIONS OF CHANGES IN TRADITIONAL PRACTICES

5.A. Changes in Traditional Practices

Since the time that the food production, resource management and social systems described in section 4 and appendix 1 functioned to the fullest, Yap and Micronesia have experienced population reducing epidemics, World War II and the successive administration of the islands by Spanish, Germans, Japanese and Americans. This has resulted in considerable change in culture and religion which modified the basis for traditional resource management.

The Spanish administration and missionaries elsewhere were largely interested in converting the indigenous population to Christianity. Today Micronesia is overwelmingly Christian - a religion which says little about resource management - other than giving people dominion over plants and animals. The Christian religion has made some former beliefs no longer credible, thus weakening the basis for traditional taboos and sanctions of a supernatural nature, without replacing their conservation function (White 1967; Ehrlich and Ehrlich,1970).

The Germans, whalers and Japanese were largely interested in exploiting Micronesia's natural resources. The dominance of Spanish influence in the Marianas and later Japanese rule in the Marianas and Carolines removed indigenous people as the principle administrators of their own natural resources. People were even alienated from their land. This resulted further weakening of the close ties between culture and resource management described in appendix 1.

The American administration, having a mandate to develope Micronesia has not been exploitive of natural resources. Indeed, many more resources have been brought to the area than have been taken out. This has alienated people from resource management in another way: as outside resources became easier to obtain, local involvement in resource management has diminished.

Today's lifestyles make limited use of natural processes or of the traditional knowledge base of working with these processes. Group concentration is scattered and there is less time for traditional technology transfer. Technologies being introduced are dollar, chemical, energy and outside expertiese intensive without an analysis of whether they are economically, calorically, socially or technologically sustainable on the basis of local resources.

The situation is now going to change dramatically. .The Compat of Free Association is designed to give Micronesians more internal control of their own affairs - and funds to develop a means of supporting themselves within a 15 year period. Local Government emphasis is now on economic development. Somehow it seems, Micronesians must find a way to support their rapidly increasing population, presumably at living standards to which they have become accustomed, via exploitation of their own resources.

5.B. Implications of Traditional Practices

The lesson from the past suggests that this may not be possible; island resources are all to vulnerable to overexploitation. Despite the fact that Yap's system of resource management of the past seemed well adapted to the islands' ecosystem, the impact of the dense populations had their effect. Today there are extensive areas of degraded soil which bear the signs of too frequent burning and over intensive use. The genetic heritage of wild endemic species is small compared to surrounding islands.

Traditional resource management required supernatural sanctions, a harsh discipline, inequality of people, resource apportionment and curtailment of individual freedom . These things are becoming unacceptable to the present generation of Micronesians, and are being discarded. This is possible because today's infusions of goods, energy and technology have made it possible to forestall the consequences of trespassing the basic rules of caloric self-sufficiency and sustainability of lifestyle so that anthropocentric indicators of the islands' limitations are lacking. When outside aid is withdrawn - and the Compact provides a timetable for this, an attempt to fill the gap may result in "boom and bust" (and not a very big boom at that) type development in which resources will be exploited at unsustainable rates and eventually depleted. The lesson of the past is clear: adaptive and intensive measures will be required if local resources are to be developed in a sustainable manner.

5.C. Factors currently relating to resource use in Micronesia

A number of the factors generally cited by development advisors as being "impediments to progress" do not limit the practice of traditional food production at least on Yap. Among these factors are problems of land tenure, attitudes toward traditional agriculture, and the demand for traditional crops.

5.C.1. Land Tenure- Most of Yap is privately owned and even Yap State Government has problems getting land for development projects. The Constitution of the State of Yap prohibits the buying or selling of land even among Yapese.

A local person in need of a place to live or to grow food, however, can ask for the use of family or a relative's land. Such requests, are seldom denied. There are numerous cases of off-island Micronesians , especially Palauans living on borrowed land on Yap. Generally there is no rent involved but some obligations are incurred. Yapese women often work together in small groups to establish gardens. By working together there is companionship, security, and the job gets done much faster, giving a feeling of accomplishment. The group may go from place to place establishing each members garden on her family's land,or the group may establish a large garden on lands perhaps owned by some members and borrowed by others. Acquiring land for commercial use - where the products of the property are not to be used for subsistence and sharing is a different matter, and at least on Yap, difficult or impossible.

The situation elsewhere in Micronesia may differ. Hezel (1985), describes some of the problems resulting from land sales in Truk in recent years, pointing out that this widens the gap between the rich and poor in Micronesia.

On Guam, which has experienced the longest period of acculturation, residents have become alienated from some 2/3 of the island's land (Karolle, 1978). Hill et al (1982) offer insight on problems involving land tenure and development projects in Papua New Guinea, and some of their recommendations, such as making land-owners part owners, elgible for dividends from earnings from development projects on their lands,bear relevance to Micronesia.

5.C.2. Attitudes towards traditional agriculture systems and official and unofficial government policies range from benign approval to benign neglect. In general it is considered good to produce as much of one's own food as possible, and people are encouraged to do so. In practice there are no specific programs to help with traditional agriculture, perhaps because it is so much a part of Micronesian lifestyle that it is overlooked.

5.C.3. Demand for traditional crops- There is a considerable demand for traditional crops, but a number of problems with their marketing, including transport, spoilage, and inconvenience of preparation. Large quantities of rice are eaten leading some experts to state that Micronesians prefer rice to traditional foods. I have presented this opinion to teachers from throughout Micronesia in workshops conducted in the last 5 years. In each case they protested that this is, at least for themselves, not so - it's just that rice is so convenient. Yapese preference for local food is emphasized by the fact that Yapese travelling off island generally take with them boxes of cooked taro and other local food.

5.C.4. Availability of labor - There is no shortage of people , especially young people to form a labor pool in Micronesia today (demographic data, Appendix II). In Yap where women do most of the gardening however, it is likely that the ratio of children to women has never been as high as today. The 1973 census showed 52.8% of Yapese to be under 15 and 1976 data shows over 50% of live births to be to women under 24 (Appendix II). It is difficult for mothers of young children to care for their babies and do the strenuous work of gardening. With considerable time now spent in school where traditional agriculture is not taught, and motherhood comming at an early age, young women sometimes don't learn and experience all they should to be as effective gardeners as their mothers. A number of young women work in town, and leave small children with mothers, aunts, etc., thus cutting down on the available work force of experienced food producers.

A major manpower problem on Yap and apparently elsewhere in Micronesia is a high incidence of drunkeness and related irresponsibility, health problems and family problems.

5.C.5. Resistance to change - Passing through experts tell people about good things and leave. When the things they thought should be done are not done, they decry people's resistance to improvement. While there has been no dearth of talk about appropriate technologies for production in Micronesia, there haven't been many examples of things that work in a Micronesian context. It remains to be shown that people, even on "conservative" Yap, are resistant to things that really function and do not require an unproportional amount of more work.

For example, though there have been agriculturists telling people how to plant open canopy crops like chinese cabbage for many years and considerable funds and projects have been devoted to the production of such vegetables, they are seldom available in local markets (unless imported), and much less in local people's diets. In contrast, it took relatively few years, and no funds or government programs for the more nutritious kang kong, Ipomoea aquatica, and "mbele", Abelmoschus manihot (figure 5), to become frequent in people's diets. In the case of the latter vegetable, Yapese women also discovered within a short time that the fibres of the stalks could be extracted and used for especially fine "grass" skirts and ornaments. Why were these vegetables more readily "accepted"? They had the endorsement of local "satisfied users". Planting material spread through traditional distribution routes,and, mainly, the plants themselves were easy to grow and fit in well with local conditions, particularly in semi-shaded villages.

Factors inhibiting the development of traditional systems include:

5.C.6. Focus on economic development- Given the expected decreases in aid after the Compact period, Micronesian governments are focusing efforts on economic development, and the only advice available for economic development via food and fiber production is for nonindigenous systems.

5.C.7. Real problems of scale,production and market uncertainties- Development experts introduce projects involving the application of money, outside expertise, chemicals, fossil fuel energy, and technology, generally in the form of bulldozers; to parcels of land larger than those generally available to individuals or groups that can cooperate in the new economic system. The experts then generally leave before there is a breakdown in the program due to such factors as droughts or storms, delay in arrival of fertilizers, feed, stock etc.; changes in personnel, misunderstandings, lack of a market for produce, lack of cooperation or vandalism. As a result, until recently, annual reports of agricultural accomplishments on Yap have largely dealt with the numbers of acres bulldozed to start projects. Given the vulnerability of Yap's soils to heavy rainfall, one wonders if the overall effect of the work might not have been impoverishment of soil.

5.C.8. Problems of Motivation and Incentive- A number of factors limit motivation and incentive to increase traditional production including the following:

5.C.8.a. The availability of new resources- It is a human tendency to avoid extra work, and there is no question that it is more convienient to store and prepare rice and open a can of sardines, than to harvest and prepare taro and fresh fish, especially when one is in the district center where a large percentage of Micronesians are concentrated.

5.C.8.b. The clash of cash- Traditional culture stresses sharing harvest, catches, and good fortune and not overcollecting resources. These resource conserving attitudes clash with the idea of exploiting resources commercially.

5.C.8.c. The clash of class - Lower classes, on Yap at least , were expected to support their higher class allies in return for protection, leadership, an. the right to use land.

On Yap at least, much of the more fertile land, and artisan abilities are found in lower class villages. Inasmuch as the fruits of traditional activities were subject to disposition by elders, chiefs and higher classes there is lack of motivation to work to produce a surplus of traditional products. It is much easier to take nontraditional jobs for pay.

5.C.8.d. The crises of leadership- Traditional leaders were granted priveleges , services, and support, presumably to enable them to concentrate on keeping their people coordinated and healthy. While such an arangement may characterize American politics, it clashes with American ideology, and the Administering Authority has had no clear policy for dealing with the existing social structure of Yap.

One Navy Administrator of Yap had a policy of providing support to ambitious young men rather than to older chiefs in order to weaken the chief's competitive (it was felt) hold over their people (Fosberg, personal communication). Today there are many kinds of chiefs. Some have a clear line of inheritance to the position, others resort to political manoeuvers , or end up in positions through default. However they achieve the status , some are content with the position regardless of whether their people or government provide the material support to carry out the role. Others agressively demand support from their people and the Government, seeing no difference between traditional support and economic support in the cash society. In addition to the chief system there are today the usual 3 branches of American Government. This has resulted in a confused system of leadership.

It is difficult to determine where loyality lies and where support to enable good leadership ends and support for personal power begins. Checks and balances are needed , but are impeded by problem e) described below, and by the complexities of living in both traditional and cash systems simultaneously. Problems of leadership have resulted in considerable internal struggle which has diverted energy and intellect which might have been devoted to increasing self sufficiency and improving conditions.

5.C.8.e. The problem of "all too quiet dignity"- It seems that in the past, and to a large degree at present, the Yapese ethic involved quiet responses. Appreciation for excellence and distain for wrongdoing are expressed in subtle and indirect ways. This is demonstrated, for example, in dance where the best dancer is not at all the most flamboyant, but rather the one who almost disappears into the dance itself.

It is often embarrassing for an adult to be directly chastised for misdemeanors, because everyone should realize that such behavior is below one's dignity, or inconsistent with some attribute of culture. Individuals not sensitive to mild or indirect sanctions, may develop unfavorable reputations but actions may not be halted. Today when these kinds of people have access to bulldozers, money, etc. which can make big things happen fast, their effect on the environment may be irreversible.

5.C.8.f. The availability of an "easy out" - One of the traditional dance forms on Yap is the "teyor", which might be characterized as an asking dance. It is most often performed by less powerful groups asking their overlords and wealthier people for help or desired things. In the past, dancers asked for canoes and the like. Today's teyors (generally performed by young girls) make requests for things like soap, perfume, canned meat, or (in one case at least),the keys to the store!

Given the social structure of Yap, and other islands of Micronesia, the easiest way to get something is to ask for it. Generally requests are not refused. Social obligations are taken seriously; money and material goods are shared, and those who provide a lot can ask for favors in return and rise in stature. It is only natural that local cultural priorities of fufilling obligations to one's kin will take precidence over a vague general goal of "development" for which there are few good examples.

Thus government jobs are viewed as the means to get money to buy things to fufill family and social obligations. Not many see their job as a means of helping their people. Indeed the idea of helping one's island as a whole has less priority than helping one's kin. Thus while the Administering Authority presumably had its ideas about the use of aid funds for "development", money comming from the U.S. has instead served to strengthen the cultural pattern of just asking for help. This has not enhanced the pursuit of greater self-sufficiency. One of the most discouraging local trends is the apparent feeling among local citizens that the Government should provide services : thus youth who formerly tended paths refuse to repair roads, saying that is the Government's (or Sea Bees) work, and parents who used to send neat little baskets of freshly cooked food or freshly husked coconuts to school with their children now assume that their children will be fed by the Government feeding program.

5.C.8.g. Micronesian skepticism towards U.S. policies - Given a history of lack of control over environmental factors of production, and of resorting to magic, it is not so inconsistent for Micronesian "rank and file" not to question the recent flow of good luck. Some leaders have attempted to straighten things out by pointing out that we must use the resources now available to prepare to support ourselves in the future. The thankless task of these individuals has been hindered by lack of demonstrable effects.*5 On one hand,Micronesians are urged to be more self-sufficient, but then are provided with Government sponsered feeding programs, and are rescued from budget deficits. A common opinion voiced in barrooms (the main venue for discussion in Micronesia), is that the U.S. is encouraging Micronesia's dependence in order to be able to use the area for its own national security, etc.

5.D. Impacts of Changes

Without a conscious effort to retain or develop existing food producing systems, we can expect these systems to erode. This has already been the case on Guam where Karolle (op.cit.) reports that the percentage of persons involved in fishing and farming on Guam declined from 90% in 1941 to 6% farmers in 1950, to less than 1% in 1970. There has been a concurrent development of dependence on food stamps.

We can expect the high islands of the Carolines to follow this pattern. While there is little reliable data on traditional food production, there are some data on imports of food. An analysis of data in the Statistical Yearbook for Yap State (Yap State Government, 1981), shows imports of food, beverages, tobacco and cooking oils increasing from about $16.25 per capita in 1954; to $299.17 and $272.94 per capita in 1977 and 1978 respectively. It is perhaps notable that the percentage of imports for imported bevereges and tobacco declined from 49% of the total in 1954 to 35% and 34% in 1977 and 1978 respectivly. The amount of USDA food imported to Yap was 0 in 1954, $82,000 for 1977; $63,000 in 1978, and $98,000 in 1979.

Because present day Micronesians have inherited relatively stable food production systems developed by more dense populations of ancestors, there is a danger of complacency. Without inputs, even the relatively stable systems will run down. The productive lifespan of a coconut tree is about 70 years. Under good conditions, breadfruit trees produce for about 50 years (Sproat,op.cit). These times are close to the productive years of each generation. If the present day population does not do its part, the next generation may end up not realizing what it had until it's gone.

Unless there is a definite effort to obtain statistics on total agricultural production, statistics gathered from sources such as market sales may be misleading. As more and more Government employees who don't have time to "grow their own" take to purchasing local foods at the market, and as export markets develop, local food prices are likely to become inflated. If Guam's situation is indicative, this will not necessarily result in an increase in producers. The overall effect may instead be reliance on cheaper imported foods.

With decreases in local production and increases in prices and population, nutritional problems may be expected to increase (Thaman 1979,1982). The U.S. is likely to respond with increases in aid, leading to dependency as in the Marianas.

A by-product of such a change would be the loss of Micronesia's genetic heritage: the wealth of adapted varieties of food plants and other species developed over a great many years by ancestors of the present generation. Another great loss would be that of the collective body of knowledge relating to the use of island resources.

Section 6: METHODS TO IMPROVE THE PRODUCTIVITY AND SUSTAINABILITY OF TRADITIONAL AGRICULTURE AND GATHERING TECHNOLOGIES

Micronesia has entered the world's "development stage" at a pivotal point in human history, when goals of short term affluence are being recognized as short sighted and are being replaced by goals of long term sustainability and survival. There will be compelling inertia to play the development game by the old rules of exploitation of natural resources. It is possible however that systems of resource use can be developed which will enable this small nation to step into the 21st century when the most modern way of life will be the wise use of natural resources on a sustainable basis.

It appears that the best way to develop such systems is to build upon the best of traditional systems. Successful systems would exhibit characteristics which mimic and extend natural processes; they would provide for water and nutrient flow, maintain a canopy to protect and develop soil at all times (such as tree gardens) or during times of heavy rainfall (such as intermitten gardens). They would also provide stability (as do tree gardens and _Cyrtosperma_ taro patches), and resilience (intermittent gardens), and be diverse so that a variety of needs can be met through the year regardless of the erratic weather pattern. In addition they should require low or no exotic inputs such as fossil fuel energy and chemicals.

The systems developed must also be socially adapted. The major factors limiting development on Yap today are not so much technological as matters of motivation and incentive.

Many of the factors currently affecting resource use do not limit production to provide for personal needs and sharing, while they do limit commercial developments. This suggests an initial strategy of encouraging production to meet local needs, and once these are met, surplus production may be marketed for economic development if this can be done on a sustainable basis. Ways of rewarding production which are satisfying to all citizens must, however, be developed by responsable local leaders. Traditional inequalities of people appear to have functioned in resource management in the past. Perhaps the time has now come to replace these with an individualized environmental ethic, and codified laws relating to resource access and management based on the functional aspects of traditional practices.

The desire to build upon what already exists has already been stated in the Preamble to the Constitution of Yap State. The Council of Chiefs has requested that Yap's traditions be codified. Traditions have already been given the force of law in both the Yap State and FSM Constitutions, and their codification would provide a more stable basis for future action.

It appears that "neotraditions" of resource use may, in some cases be needed. These would involve technologies adapted, via a combination of traditional knowledge and experience and modern science, to today's conditions; which are satisfying to today's human spirit. A strategy for achieving this follows:

6.A. Protect currently functioning systems

Assessments are needed prior to the undertaking of development projects to weigh sustainable benefits, and environmental costs of projects. Actions to decrease negative impacts of chosen projects should then follow. For example the construction of roads has altered drainage patterns and affected water circulation in taro patches. In some cases the impact is obvious: the taro gets half buried. In others the microbiology of the substrate is changed, generally towards more anaerobic, foul smelling conditions. Appropriate measures should be incorporated into construction plans to avoid such environmental oversights.

6.B.Evaluation of existing systems-

Existing traditional production systems need to be evaluated concurrently. Little data is available on the productivity, particularly net productivity, of traditional agriculture in Micronesia. Sproat (op cit.) gives information on yields of some crops, but does not state whether this data applies to Micronesia. An attempt was made to census production in the traditional sector of the TTPI (Office of Planning and Statistics, 1981) but the results are hardly reliable. *6

A recent U.S. Forest Service project to map vegetation on the high islands of Micronesia revealed considerable acerage devoted to traditional agroforestry. A project to do a more in depth agroforestry study has just been initiated in cooperation with Yap State.

Once existing traditional and neotraditional production systems have been evaluated, they can be compared with other systems and enhanced as needed. Comparisons of caloric and other inputs vs production and sustainability of traditional vs new technologies should be examined. New technologies with all their inputs of money, fertilizers, energy etc., are of course impressive, and lead people to disparage their own systems of production. Comparisons of caloric and other inputs vs production by both old and new technologies should be presented.Such research would help the people of Micronesia recognize the things of value that they now have, and evaluate needs for new technology.

6.C. Establish guidelines for development

Concurrent with the above, there is a need to establish guidelines for development which would assure at least the sustainability of a subsistence base and that economic development projects be sustainable.

It would seem to be a truism of development theory that people should not end up poorer then they were before development efforts. When people can become alienated from their land, they are subject to the problems cited by Hezel (op cit), and are rendered obligatorily dependent on others or on the world economic system. Given the insular problems of isolation, logistics of exchange with the outside world, limitation of energy resources, diseconomics of scale, and instability of the world economic order and markets, it would seem that a "Micronesian Bill of Rights" or "insurance policy" might include a provision that Micronesians should not be denied, or deny their children, the right to at least subsistence self-sufficiency based on the resources of their lands and marine areas. Such a provision would of course, be a legal can of worms. The concept provides a valid rule of thumb for development efforts however.

6.D. Enhance existing systems - Below are suggested some methods to enhance existing systems:

6.D.1.- The processing and/or stabilization of produce so that it can be stored and marketed

6.D.2. Find markets for such produce - The most direct step to be taken here is to conduct a pest and disease survey of Micronesia to provide a basis for U.S Federal quarantine regulations affecting Guam and other potential markets. It appears that most of Micronesia's traditional crops are relatively disease free and could be exported to at least Guam if quarantine regulations were revised.

6.D.3. Fill seasonal gaps - Figure 3 depicts production averaged from a number of years of data. This may be misleading. There are on some years gaps in production. With better predictability of rainfall patterns, new cultivars and new technologies it may be possible to fill some of these seasonal gaps.

6.D.4. Develop taro patch culture - There is ample habitat for taro culture, and if a means of stabilization and marketing of products were developed, there is potential for increased production. Research needs include: the control of a number of taro diseases to increase productivity, an understanding of the nutritional and other requirements of taro and culture methods by which these may be provided, including water management. An improved means of predicting corm quality before harvest would also be useful. The place to start is with investigation of the best existing taro patches by a team consisting of a modern scientist and the woman who tends the taro patch. The local expert often knows what to do to obtain good results but not why - at least in terms of modern science. The job of the scientists would be to figure out why her methods work so that the two of them can then expand upon the methods to develope "neotraditional",enhanced systems of production.

6.D.5. Introduce suitable new species - Micronesians are quite interested in new varieties of plants and have already smuggled in a remarkable number. Because of the danger of introducing pests and diseases, this process should be improved. There is need for screening systems and facilities for tissue culture, etc. to obtain disease free planting material.

Prior to the introduction of many new varieties however, there should be an intensive effort to collect and maintain existing varieties. A fascination with the new too often leads to discarding old varieties which could remain useful for a variety of reasons, particularly in breeding programs.

6.D.6. Improve fallowing methods - The fallowing period required for Yapese gardens is quite long, and might be improved via the use of nitrogen fixing legumes, which might also provide useful products such as posts, fodder, etc. Care must be taken in chosing varieties. For example, though it is fairly spectacular, the highly touted giant Leucaena is difficult to control and grows tall enough to shade out fruit trees if not curtailed (personal observation).

Micronesia could probably profit from the work on "site stable agriculture" conducted by the Wau Ecology Center in Papua New Guinea.

6.D.7. Promote exchange among Micronesians and between Micronesians and people from other tropical areas - Micronesians and people from other tropical areas can learn a great deal from each other due to the specializations in different areas.

6.D.8. Assist traditional women gardeners - Given the fact that women are the main gardeners on some islands, and the fact that the proportion of children to women is quite high, there is need to assist women in caring for their children as well as in gardening and in passing on their experience. More effective low profile family planning assistance is needed, as is some improved system of child care. (It is important though that help in this area does not remove parental responsability.) The efficiency of "traditional technology transfer" must be improved if such technologies are to survive and continue to develop.*7

6.E. Introduce relevant New Systems

There is considerable interest in the enhancement of food production via new systems of sustainable technology such as biogas systems, fish ponds,solar energy, improved local fuel stoves etc. The limiting factor here is not so much a dearth of ideas as lack of continuity and support for local people to actually experiment with new methods , to work out problems and details of operation, and adapt the new technologies to meet their needs.

Most support for the researching or "demonstration" of "appropriate technology" for Yap has gone to outsiders *10 ,who are perhaps more efficient at writing proposals, and getting projects completed and reported to the funding agency. That the technologies often don't spread is overlooked or else attributed to failure to do a preliminary "social analysis". Local people must incorporate such "social analyses" into their actions. If there is to be a serious investment of their own time, resources and social standing, they are more selective of projects and slower to accomplish them. If carried to completion however, the liklihood of "technology transfer" is much higher. Thus the most effective means of encouraging appropriate technology is the provision of sustained support, both financial and technical, for responsible local innovators.

6.F. Improve the productivity of savannalands-

One of the most positive things that could be done to improve sustainable food and fiber production in the area of utilizing new technologies would be the aforestation or reforestation of savannalands and other degraded lands (Marshall, 1951; Stone,1970 p.31).These lands are quite extensive, especially in the western Carolines, and appear to have been degraded beyound local means to reclaim them. They are utilized for traditional agriculture only when more fertile areas are not available. Their improvement would have only positive impact on the potential for increased food and fiber production. The steps involved in such reclamation include:

1) An inventory of degraded lands to classify them into subtypes

2) Protection of suitable areas of endemic communities (see Falanruw, 1976 for description of communities on Guam, and upcomming Forest Service vegetation maps for information on other islands of Micronesia).

3) Develope a program of fire prevention including the construction of firebreaks, public education , and improving the means of fighting fires and enforcing fire laws (see Stone,1970 p. 32-33 for description of the fire problem).*13

4) Establish reforestation plantings on selected degraded lands utilizing local species as well as selected exotics where

necessary. Include plans for controlling agressive exotic species and conversion of areas to more useful species.

5) Inasmuch as minimal use of these lands is made for subsistence food production, their enhancement and eventual use might be earmarked for economic development - if the gains in productive land is not cancelled out by rapid population expansion.

6.G. Assist with the development of a neotraditional individualized environmental ethic

Inasmuch as many traditional practices having conservation value were in the guise of no longer credible religious or cultural taboos, they were not incorporated as an individualized environmental ethic, and their conservation function is being or has been lost. If Micronesian development is to be sustainable, it is important that this gap be filled.

Recent U.S. Fish and Wildlife sponsered workshops on environmental education indicate an interest and recognition of a need for this subject (YINS 1984).

Section VII. AVENUES FOR ACTION

VII.A. Enhancing local involvement

Resources cannot be managed without the involvement of the people whose resources are being managed. The most important avenue for implementing beneficial changes in Micronesian resource use is greater local involvement and support for local efforts. American funds over the years were intended to fuel development, however a combination of a focus on political and social development and lack of experience and expertiese in tropical resource management essentially resulted in benign neglect of local natural resources.

A great deal of help with natural resource management is needed in Micronesia, however in the interest of increasing Micronesian involvement in their own resource management, the appropriateness of extending whole federal and U.N. programs and agencies to Micronesia should be examined. Such an approach leads to problems becoming institutionalized rather than being addressed directly.

The institutionalism of problems sometimes leads to overhead and bureocracy often out of proportion or not directly relevant to the real problem at hand. Group after group comes out on brief familiarization tours, and much effort is expended trying to fit the Micronesian need into an existing program or existing methodology. The original problem is generalized and the project expanded to include the whole American Pacific, or Pacific and to justify expansion of the federal program. Sometimes federal agencies lack expertiese in needed areas. A report from one agency pointed out that it lacked expertiese in tropical areas, yet recommended that Micronesian funding be provided for its services, and included in its recommendations that Micronesians be trained to assist visiting scientists.

More serious is the impact of the myriad agencies and bureaucracies on the efforts of local personnel. One local official involved with development remarks: "I no longer have a chance to act. All I can do is react to all the visiting representatives , agencies and programs."

It might well be more effective to just address problems directly, by sending a technical specialist, if needed, to work with local personnell for an adequate length of time to either solve the specific problem at hand, or if it is indeed larger in scale, to help develop a strategy for addressing it. Micronesians tend to deal with specifics and then enlarge on these. The American tendency to establish generalizations first is harder to understand and appreciate, especially when the original specific problem is not immediately addressed. Institutionalization of functions may be necessary in a large country like the United States. In Micronesia however, problems are at a smaller scale, and may be addressed more directly.

Outside Aid organizations seem to ignore the creativity and experience of the people they profess to help. Thus for example, there is considerable support for research for outside experts to develop things to be told, taught or demonstrated (in that order) to island people. There is relatively little support enabling people in need to try out things for themselves and where useful, incorporate them into their lives. The provision of such support at this time, when people have an interest in enhancing existing adaptive systems is vital. If today's trends continue, people will come to aspire for less adaptive technologies and technologies which cannot be supported by island resources.

VII.B. Need for local institutions dealing with resource management

The problems of managing outside expertise and providing timely and relevant information on adaptive technologies would be alleviated by the development of a network of local institutes dealing with integrated sustainable resource management. At the present time there is no such local function in Micronesia, and no experience from past administrations or cultural precedent for intentional integrated resource managment.*14 Government offices are greatly influenced by requirements and priorities of outside agencies on whose funding they so often depend. In addition, the Government focus is on economic development the only precedent for which is the exploitation of resources.

There is considerable need for a network of local nonaligned institutes - similar to the U.S. OTA, which could evaluate technologies relating to sustainable integrated resource use. The commitment of such an institute would be to the island and nation it serves. It would function as an information gathering,and evaluative center which tries out and helps other residents try out new technologies which appear to be adaptive. The institute would help government offices by providing information and independent evaluation of projects before political commitments are made and thus would serve to defuse presumed conflicts between "development" and "conservation" by disclosing any problems in sustainability early in the consideration of projects. Such an institute would help define problems and determine if and what outside expertiese is needed.

Given the isolated nature of Pacific islands and high transportation costs, such an approach seems justified. It is not clear however where funding for such local institutes would come from. One possibility suggests that savings gleaned from the overhead needed to support bureaucracy survey trips for representatives of outside would provide ample monies to support a local agency which could evaluate problems determine the need of outside expertiese. Such local institutions would not obviate U.S. Federal and other agencies. They would however make more relevant use of their technical assistance.

Staff limitations of such local institutes might be alleviated by the creation of a network of such institutes throughout Micronesia, having good communication between themselves and with top quality expertiese outside of Micronesia.

VII.C. A strategy for improving sustainable integrated food and fiber production

The value of incorporating the traditional knowledge base into development efforts is discussed by Hill and others (In: Morauta et al, 1982). Many recommendations are being made to assess traditional food production systems in the tropics Gleissman (1985), has estimated that it will take some 10-15 years for U.S. Universities to develop the expertise to do this. This is precisely the amount of time available to Micronesians to utilize Compact funds to develop a support base prior to decreases in funding levels. There just isn't time for such an institutional approach. A more timely strategy to meet Micronesia's needs might involve the following:

VII.C.1. Present the results of this OTA study to Micronesian leaders in a series of workshops to develop guidelines for development assuring at least the sustainability of a subsistence base, and that economic development projects be sustainable.

VII.C.2. Follow this workshop with support for the development of local institutes dealing with sustainable integrated resource use in Micronesia, and develope a network of these local institutes with top quality outside experts, including expertise from U.S. Federal Agencies.

VII.C.3. Once there is resident ability to evaluate the sustainability of development projects and to work in counterpart with outside expertise the steps listed in Section VI may be carried out including an evaluation of existing traditional food and fiber production systems, enhancement of existing systems, the introduction of relevant new systems, and development of a neotraditional environmental ethic.

Section VIII. SUMMARY OF CONSTRAINTS AND OPPORTUNITIES

Summary:

Traditional agriculture appears to offer a means by which Micronesians can feed themselves. The system appears to be relatively adaptive and sustainable. Caloric production is probably higher per unit of caloric input than western type agriculture as a result of incorporating natural processes into the system. More research on the systems present and especially their net productivity is needed. The requirements and production possible via new technologies also needs to be evaluated.

The major constraints of traditional agriculture are its requirements of area and time for natural fallowing and replenishment of soil nutrients. The technology of traditional agriculture is also dying with the older generation. In addition, the ease of obtaining and preparing imported foods and limitation of markets for the products of traditional agriculture limit motivation for its improvement.

It appears that traditional agricultural technology can be enhanced by modern "agroecological" technology such as "site stable agriculture developing at the Wau Ecology Center in Papua New Guinea, the incorporation of more efficient green manures into the fallow phase, etc. Local resource institutes can help compile and evaluate traditional agricultural technology with the help of organizations such as CATIE experienced in the tropics. The resulting mix of the best of traditional and modern practices can be incorporated into the school curriculum. This will serve to demonstrate the new technologies to the community. Those which are adaptive and satisfying to local needs will spread and enhance local self-sufficiency.

The expansion of traditional agriculture to provide exports for economic development will require the development of markets, possibly some social restructuring, and careful bioeconomic analyses to determine net returns. It is possible to improve on existing systems, but we should not, at this point, presume that Micronesia's limited land can provide both sustanence and economic returns equal to current levels of aid. Support for a great deal of sustained local work is still needed.

The major opportunity which lies before the United States in the area of integrated renewable resource management is the formation of a partnership to develop a neotraditional model of integrated resource management for the Pacific with considerable implications for the rest of the tropical world. As the livlehood, identity and integrity of Micronesians is closely allied with the use of their natural resources, the value of this effort to Micronesians is obvious.

The assets which the U.S. could bring to the undertaking are considerable. Those of Micronesians consist of a body of collective knowledge of many generations, and a situation where problems are at a human scale.

The constraints of the undertaking include a transfer of support from programs fostering dependency to programs building self-sufficiency. This will involve some changes in attitudes.*11

The relevance of Federal programs will have to be evaluated, and support provided for the development of local institutes dealing with integrated resource managment to focus on local details in order to assure that support is applied where it will do the most good. Local expertise will have to be developed and the U.S. will have to demonstrate that it is not trying to create dependency.

Micronesians bear a responsibility to believe in themselves and their heritage, accept and act on the fact that responsible hard work is the most important ingredient in self-reliance through wise management of natural resources on a sustainable basis. They must ask good questions, make valid requests, and insist that outside agencies serve them as intended ("that the dog wags the tail, rather than the other way around", in the words of Governor John Mangefel).

Footnotes

*1 The term "savanna grassland" is used here as it has been utilized in past literature on the vegetation of Micronesia (Fosberg,1960). In discussions on the Carolines the terms "Pandanus grass and fern lands" is also used for similar type areas.

*2 I have seen no literature documentation of this last statement, however Yapese women have instructed me on choice of varieties and in ways of growing taro to avoid diseases. Some of this advice has made a great deal of sense in relation to literature on at least *Phytopthera* taro disease and its management.

*3 *Cyrtosperma* can be maintained to some degree by placing freshly harvested corms with portions of the stalk left on in shaded mud. The Yap Institute of Natural Science (YINS) has experimented with storing this taro in plastic bags with some success but more work is needed to perfect the method.

*4 The author's experience controlling fires about an area she is trying to convert from grassland to agroforest is indicative. One adult who started a fire that got away, just left the site. On another occassion, the adult who started a fire that had just got out of hand was found sitting there chewing betle nut, and merely exclaimed the equivalent of "oh there now!" when she described how the fire got out of hand. On yet another occassion, neighbors came to help when the author was cutting a firebreak to

Source: Yap Almanac Calendar. Environmental Education feature targeted for youth involved in arson.

IT'S NOT COOL TO BURN

The greeness of Yap does not mean we have good soil. Most nutrients for growth come from the fall of leaves and debris from trees. Our forests feed themselves. It takes a long time for this recycling system to build soil. Once broken, the cycle is hard to re-establish. Trees and grass also soften the force of rainfall and help soil absorb water. When vegetation is burnt, the soil loses its protection, is baked hard by the sun and water runs off into the sea carrying nutrients that might otherwise have supported food and materials for our homes. Runoff makes the lagoon less productive. Gardens are often cleared by burning and the ashes used as fertilizer. These work for only a short time however and then the garden must be left fallow a long time to recover. Land that is burnt over and over becomes poorer and poorer. Burning the teid kills young trees so the land can't recover. Youth need this land for their future. What kind of monster is burning our island? Fire breathing demons? No. Not even a demon would destroy its own home for pleasure.

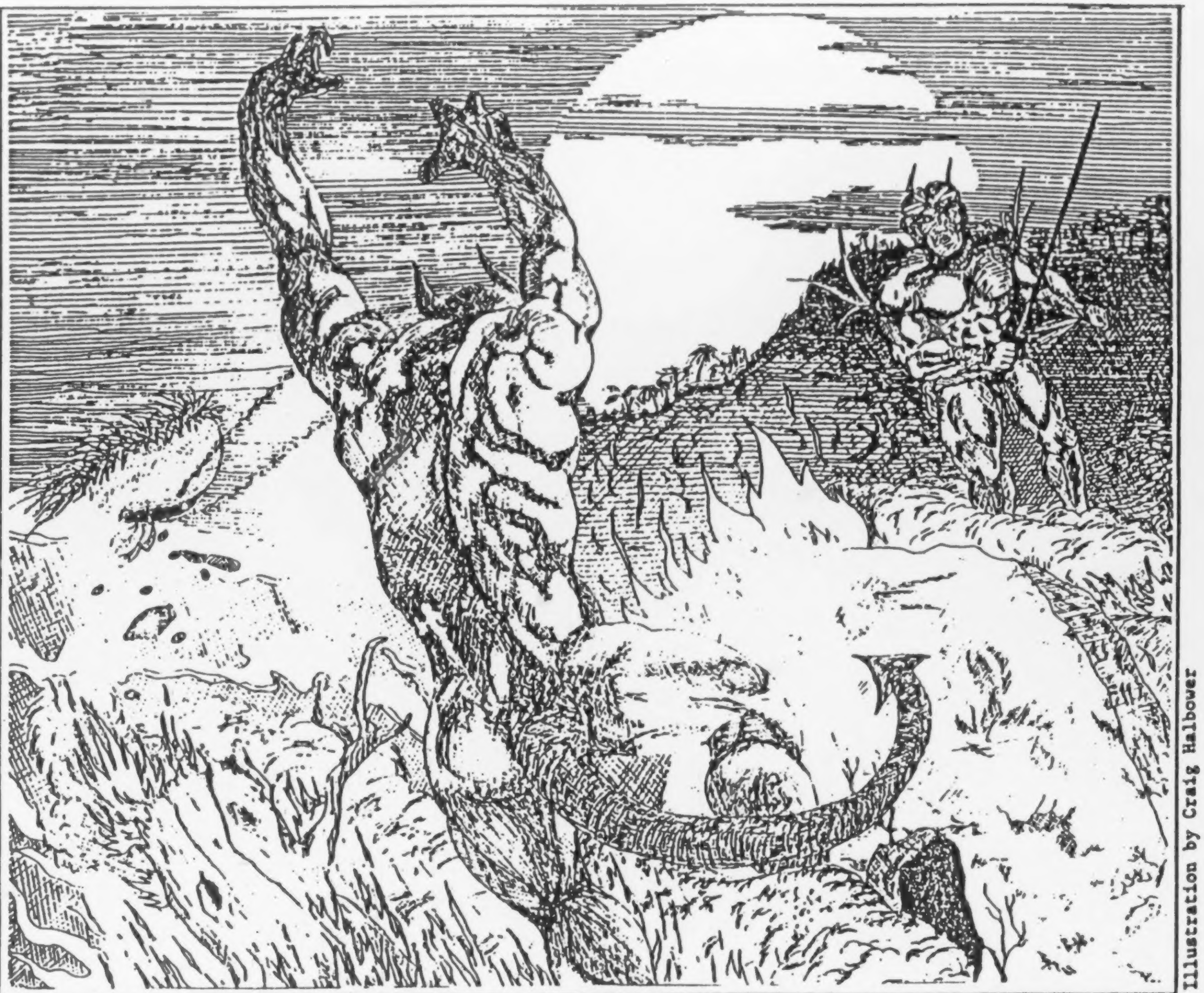


Illustration by Craig Halbower

stop an advancing grass fire. In their excitement (and unanalized)efforts to help, the adult neighbors were gathering the dry grass , and piling it below the wild trees I had been encouraging to grow- so that they would burn more completely when the fire reached them!

Children have more readily gotten the idea of controlling fires as it is challenging and sometimes fun. When they occur in grasslands, such fires can often be controlled by waiting until the wind and fire dies down and then beating them with "mops" of leaves at the ends of branches, etc. This is seldom done however, and such fires are generally left to burn themselves out.

*5 For example, sometime back there was concern about the energy crises, and local plans for energy conservation were made, including an accellerating rate to reduce Government subsidy of costs of electricity to the private sector, so that people would begin to understand the true cost of the service and consider energy conservation and alternatives. In the midst of these efforts came conflicting opinions (from an American ex-politician working on Yap, among others), that the energy crises was not real, and that the U.S. would increase subsidies- and so they did.

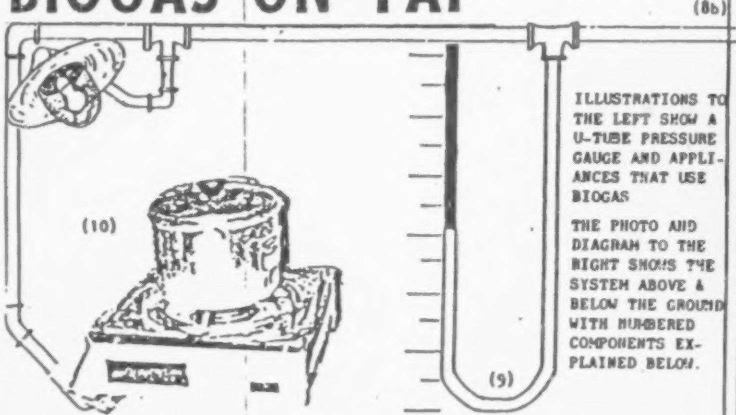
*6 The project seemed to have been designed by people unfamiliar with Micronesia. Actual data is limited and results include some surprizes (such as the census of some 85 caraboo and 13 donkeys/mules on Truk and Pohnpei respectively!), and conclusions include statements like: " in all liklihood the average yields vary."!

*7 One way of doing this is the incorporation of instruction on traditional food production into the village school curriculum as has been initiated by YINS for the 7th and 8th grades. One problem with such an effort is that a lot of techniques are secret and only "given" to obedient children. Enough is known however that the basics can be taught in schools. Then youth can be "finished off" by appropriate relatives. The author has found that one of the problems with traditional knowledge is that it is a mixture of useful and superstitious elements, some of the latter being less than useful or counterproductive. The above scheme would make no judgements on this matter. By teaching what is known to useful, and obtaining the help of parents willing to share knowledge, we will gradually develope improved practices. Secret knowledge which is beneficial will become more valued, and that which proves to be neither productive nor satisfying will fall into disuse.

*8 On the matter of improved local fuel stoves for example: Local girls have been trained at CETC in Fiji to make chula stoves but these have not caught on. A Fijian woman investigated these stoves and found that they are less efficient than the local open fires (Siwatibau 1978). Nonetheless there have been several demonstrations by outside experts of how to build these stoves on Yap. YINS, being aware of Siwatibau's work attempted to build improved stoves (YINS 1981) of these were useful to women wanting to cook more than one pot at a time or in a variety of ways. Others went unused because although more efficient than chula stoves, they still required more fuel than carefully tended local fuel fires. YINS is aware of improvements

Fig. 5. Source, Yap Almanac Calendar, 1985

BIOGAS ON YAP



ILLUSTRATIONS TO THE LEFT SHOW A U-TUBE PRESSURE GAUGE AND APPLIANCES THAT USE BIOGAS

THE PHOTO AND DIAGRAM TO THE RIGHT SHOWS THE SYSTEM ABOVE & BELOW THE GROUND WITH NUMBERED COMPONENTS EXPLAINED BELOW.

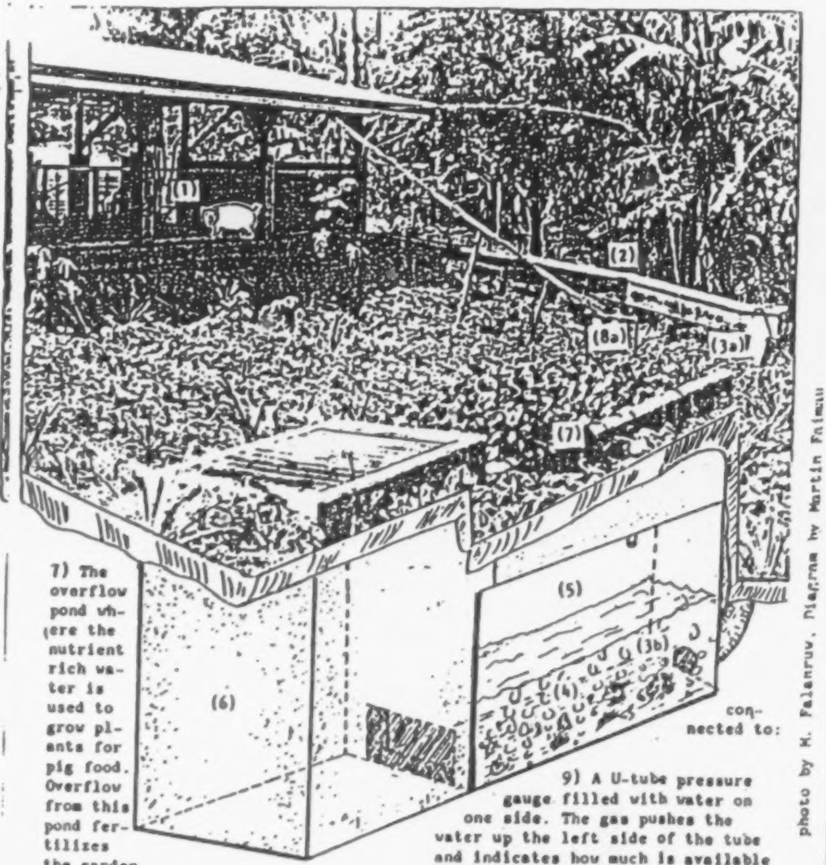


photo by M. Falanruw, Diagram by Martin Falmuw

ack in January 1977, the Ecodevel-
pment column of Yap's Carolines
bserver newspaper carried an art-
cle on biogas systems. Through the
ears there has been no dearth of
ords devoted to this idea. Now how-
er, we have the most important in-
redient: an example of an ecologic-
lly sane development that works!

ap's biogas system was built by
he Dave Nelson family and relativ-
s of Woogem, with funding from a
SM energy grant and plans obtained
rom George Chan and modified some.

biogas system emulates Nature in
ecycling wastes and produces fuel,
ertilizer and food.

) We start with a source of waste:
igs in the pens shown to the right.
families sewer system can also
low into the tank.

2) Wastes from the pigpens are washed daily into a trough which flows into:

3) A pipe (3a & 3b) which empties into:

4) The digestion chamber which is a big cement box with wastes, water and bacteria that can live without oxygen and get their energy from breaking down the wastes. In the process, methane gas is produced. This gas bubbles up into:

5) The biogas chamber. As the gas accumulates in this chamber, it pushes water from the horizontal part of the digester up the:

6) Water pressure tank. The weight of water in this tank keeps the biogas under pressure. When full, this tank overflows into:

7) The overflow pond where the nutrient rich water is used to grow plants for pig food. Overflow from this pond fertilizes the garden.

8) The pressurized biogas flows into the gas pipe (8a & 8b) which is

connected to:

9) A U-tube pressure gauge filled with water on one side. The gas pushes the water up the left side of the tube and indicates how much is available for:

10) Biogas appliances. These include stoves, lantern and other machines

which can be made to earlier models but does not have support to follow-up on the work. In the meantime, there will probably be several more demonstrations on the building of chula stoves...

There has been no dearth of talk about biogas systems, however it was not until support became available for a local family to build such a system that Yap ever saw one (fig.5). Yap now has both an example of a working system and the technical expertiese of a U.N. Volunteer to build such systems. The U.N. Volunteer can provide vetrinary services and has also worked out a formula for local feeds. Initial efforts have involved an applied workshop to train people in pig husbandry and to establish piggeries.

The building of functional biogas systems involves more support than the simple, practical piggeries involved in the first phase of the project. Water is needed to wash wastes into the system on a daily basis. Yap lacks adequate water systems for people. Thus a program to build biogas systems could result in improved water systems for families as well as improved sewage systems which will help alleviate the considerable problems with intestinal parasites. The key to the whole effort is the availablity of sustained support for the local effort however.

*9 One example of a useful federal project was the Fish and Wildlife census of resident birds, something which would not otherwise have been done. This project was carried out in a professional, yet locally sensitive manner, and included the trainning of local personnell.

*10 This change was interestingly summed up by one of Yap's outer island leaders who responded to an American development advisor's discussion of the need to increase local production with: "You mean you have given us the bottle and now you're telling us to go back to the breast!"

* 11- On livestock & feral animals: On Yap, pigs are always kept tethered or penned so that they will not damage gardens. Sometimes tethered or penned pigs are used to weed and fertilize areas. Chickens are fed but allowed to roam and forage for themselves. They do present a problem when they scratch up vegetable seedlings, new plantings, and tuber crops such as *Xanthosoma* taro. Fruit bats , Micronesian starlings and bridled white eyes may damage tree crops such as ripe bananas if these are not picked before they ripen. These birds and fruit bats also aid in seed dispersal however.

Deer (actually the Marianas Elk, *Cervus mariannensis*), do not seem to be a problem for agriculture on Guam. There are deer on Pohnpei but I have not heard of their being an agricultural problem there. Pigs are allowed to roam free on Pohnpei and necessitate the building of rock walls to protect plantings. Inasmuch as pigs are not penned it is likely that the introduced goats will not be kept penned and can be expected to cause additional problems. Feral goats are present on the islands of Agiguan, Anatahan,Sariguan,Agrihan in the Northern Marianas and have been very destructive of the native vegetation especially on Sariguan where feral pigs are also present in lower areas. (Falanruw, pers. observations).

Fosberg,1960 points out that native forests in Micronesia originated in the absence of large browsing animals such as wild hogs, deer and cattle, and these can be very destructive to the native vegetation. This appears to have been the case in areas of Guam , and Tinian as well as Sariguan. The native forest of the small island of Rota is currently being degraded as a result of efforts to raise cattle. The bioeconomics of these efforts should be investigated. In general, economic development loans are obtained and used to buy barbed wire which is stretched around forested areas, some of them with stands of young *Intsia bijuga*, a very valuable tropical hardwood. The cattle browse and open the area at which time it is invaded by the aggressive weed *Eupatorium odoratum* which ruins the pasture. Thus another area of forest must be degraded. An analysis to compare the short term earnings from such cattle ventures with the longer term earnings that might be derived from the management of the young Intsia trees in such areas is needed.

*12 Except for Guam, efforts to educate the Public on the negative effects of extensive burning has been limited. YINS has included the topic in its environmental education workshops for teachers, Earth Day observations with students, and Public information efforts ~~(Fig.4)~~. It has been noted that the incidence of fires has not decreased with an increase in anti-burning programs on Guam, and on Yap the Department of Agriculture extension worker who went from school to school to talk with students about the problem during the dry season reported newly set fires on his return trip and discontinued the effort. Fire education materials are currently being integrated with 7th & 8th grade environmental education materials ongardening and natural communities which are presented prior to the dry season.

Guam has an active Federally funded fire and reforestation program (Guam Department of Agriculture 1983-1985 Annual Reports). The U.S. Forest Service sponsered a workshop in 1985 which delt with investigating and controlling fires. This workshop was attended by firefighters from Guam and foresters from Guam , the Northern Marianas, Pohnpei and Truk.

APPENDIX OF PLANTS MENTIONED IN TEXT

Scientific name	Common name*2	Part of plant used/ how? *3
Abelmoschus manihot	bush spinach	leaves cooked as greens, very nutritious
Alocasia macrorrhiza	wild taro *4	famine food
Annona spp.	"laguana'"(Guam),soursap, etc.	fruit, eaten fresh or can be madeinto drink
Areca catechu	betel nut	masticatory, cultural chew (see fig. on next page)
Artocarpus spp.	breadfruit	fruit cooked as carbohydrate staple, seeds also eaten
Artocarpus mariannensis	seeded breadfruit	fruit and seeds cooked and eaten
Averrhoa spp.	pickles & starfruit	fruit eaten fresh or made into drink etc.
Bamboo	bamboo	building material, sprouts cooked as food
Benicasa hispida	wax gourd	cooked in soups, drinks, etc.
Carica papaya	papaya	fruit, eaten fresh or cooked
Citrus	oranges/lemons/limes	fruit, eaten fresh or as juice, jelly etc.,spice
Cnidoscolus chayamana	"chaya"(Mexican),"kadagan" (Guam)	leaves & tips cooked for greens
Cocos nucifera	coconut	many uses for whole tree (see attachment)
Colocasia esculenta	"kukua" taro	corms cooked as major staple, leaves cooked as greens
Crataeva speciosa	"abich"(Yap)	fruit cooked as vegetable, strong smelling
Cucurbita	pumpkin	fruit and vine tips cooked as vegetable (see fig.)
Cycas circinalis	cycad	fruit leached of poison, dried, ground & used as flour
Cyrtosperma chamissonis	"lak" taro	corms cooked as major staple
Dioscorea esculenta	------ yam	tubers cooked as major staple
Dioscorea alata	------ yam	tubers cooled as major staple
Dioscorea nummularia	------ yam	tubers cooked as major staple
Eugenia spp.	"apple"	fruit eaten fresh, etc., leaves used medicinally
Gleichenia	~~staghorn~~ fern	formerly used for walling material
Hibiscus tiliaceus	"tree hibiscus"	fibrous bark used for cordage, "grass" skirts, etc.
Inocarpus fagifer	"bu'oy" (Yap)	fruit cooked as food, wood used for handles, etc.
Ipomoe aquatica	kang kong	leaves and vine tips cooked as greens, (see fig.)
Leucaena leucocephala	"tangantangan"(Guam)	introducedsecondary shrub to tree used as firewood
Macaranga carolinensis	"bith"(Yap)	secondary shrub to tree used medicinally
Mangifera indica	mangoes	fruit eaten ripe & unripe, can be used forlumber
Mimosa invisa	"spiny mimosa"	noxious introduced weed
Morinda citrifolia	"lada" (Guam)	leaves used medicinally, fruit famine food, also dye
Musa spp.	bannana	fruit eaten ripe or cooked green, fibers used
Pangium edule	"rowal" (Yap)	fruit eaten when ripe (otherwise poison) of some var.
Pandanas	Pandanus	leaves used in weaving, ~~fresh or~~ ripe fruit eaten
Piper methysticum	sakau	ceremonial drink- called "kava"(Samoa), or"yangona"(Fi
Policias spp.	panax	ornamental, used in "grass skirts", etc.
Psidium gujava	guava	fruit eaten fresh or made into drink, jam etc.
Pteropus	fruit bat	whole animal cooked & eaten
Spondius spp.	"titimel"(Belau)	leaves/soup flavor, fruit/drink
Tacca spp.	arrow root	tuber made into starch for pudding,medicine,etc.
Terminalia catappa	"tropical almond"	nut eaten, made into candy, etc.
Theobroma cacao	cacao	fruit can be made into coco
Xanthosoma	------ taro	corm cooked and eaten as starch

footnotes to appendix of locally used plants

*1 - A complete listing of locally used plants would take a book - (I'd like to write such a book someday). This list is confined to plants mentioned in the paper.

*2 - Only the most common english name, or one of the many local names is given here. There are many names for the many varieties of some of these species on one island as well as different local names for each species in the different languages of Micronesia.Many plants in Micronesia have no common English name.

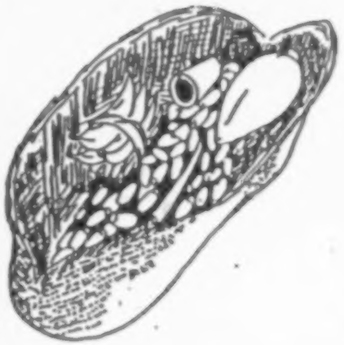
A computorized, cross-indexed listing of scientific, local and where they exist, common English etc. names of trees and shrubs in the American Pacific has been compiled and will be published by the Institute of Pacific Islands Forestry, U.S. Forest Service.

*3 - Only main or a few uses of these plants is given here. Most have multiple uses, both traditional, and new.

*4 - Technically only Colocasia should be called "taro" - but the name is often extended to other members of the alocaceae family. There are more than one species of "wild taro", Cyrtosperma chamissonis might be called "giant swamp taro". It is most important in Yap, thus is refered to by the Yapese name "lak'" in the paper. Colocasia is the "true taro"- very important in Belau, thus is referred to by the Palauan name "kukau" in the paper. Xanthosoma is relatively new, having been introduced from the New World tropics. It is sometimes referred to as "Honolulu".

Source: Yap Almanac Calendar

BETEL NUT



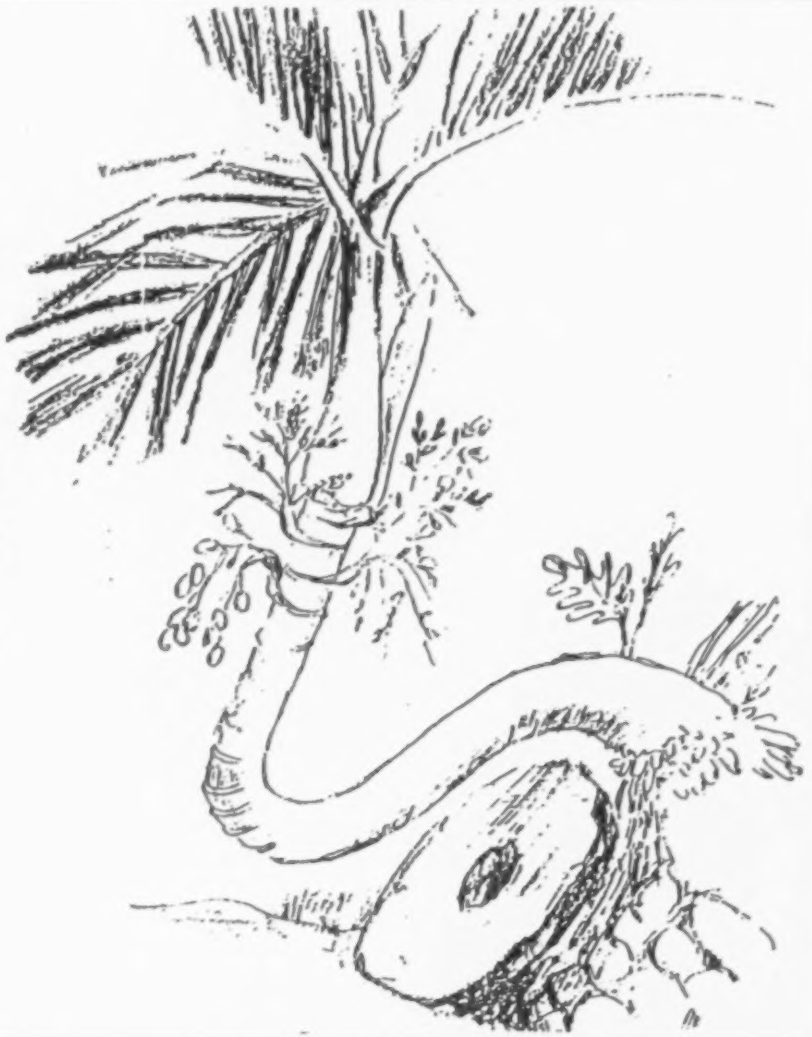
Betel nut chewing has been around a long time. It was first described by Herodotus 340 years before Christ. The habit ranges from the east coast of Africa to India, Burma, Malaya, Indo-China, southeast China, East Indies, Philippines and parts of Oceania. The betel nut palm is native to Malaya but now grows in many parts of the world. The Yapese name for the nut, "bu" has many cognates such as "buwa", "pugua", and "pu", and is possibly derived from the natives of Malay called "Punou" or "Bunou" who brought the habit to Taiwan.

Yap seems to be the betel nut capital of Micronesia and most everyone carries a betel nut basket with them. The picture shows a basket somewhat exaggerated to show its contents : a lime shaker made of a small coconut shell, a bundle of pepper leaves, "gabuey", green nuts, and for older people, a mortar and pestle for prepounding the quid. There a various customs associated with betel nut baskets like not stepping over another person's basket and young people not reaching into older folks baskets.

On Yap chewing betel nut involves splitting a green nut, sprinkling it with lime, "wech", wrapping it in part of a pepper leaf, and chewing the whole thing together. Some people add twist tobacco. In other places the mature nut may be chewed either alone as in modern day Guam, or with spices and condiments as in India. In India, Pakistan and Burma an extract of the heartwood of the tree is chewed with the quid, and in various places the pistillate infloresence or underground stem of the pepper vine may be added.

According to stories, ghosts chew too. Sometimes when a sailing canoe stops mysteriously in the lagoon, the sailor prepares a special betel nut quid, wrapping it with other leaves and tying it tightly with many knots. The bundle is thrown into the water and the canoe sails away while the ghost is busy untying the knots!

Illustrations by Stanley Kenrad



Source: Yap Almanac Calendar

COCONUT: TREE OF LIFE

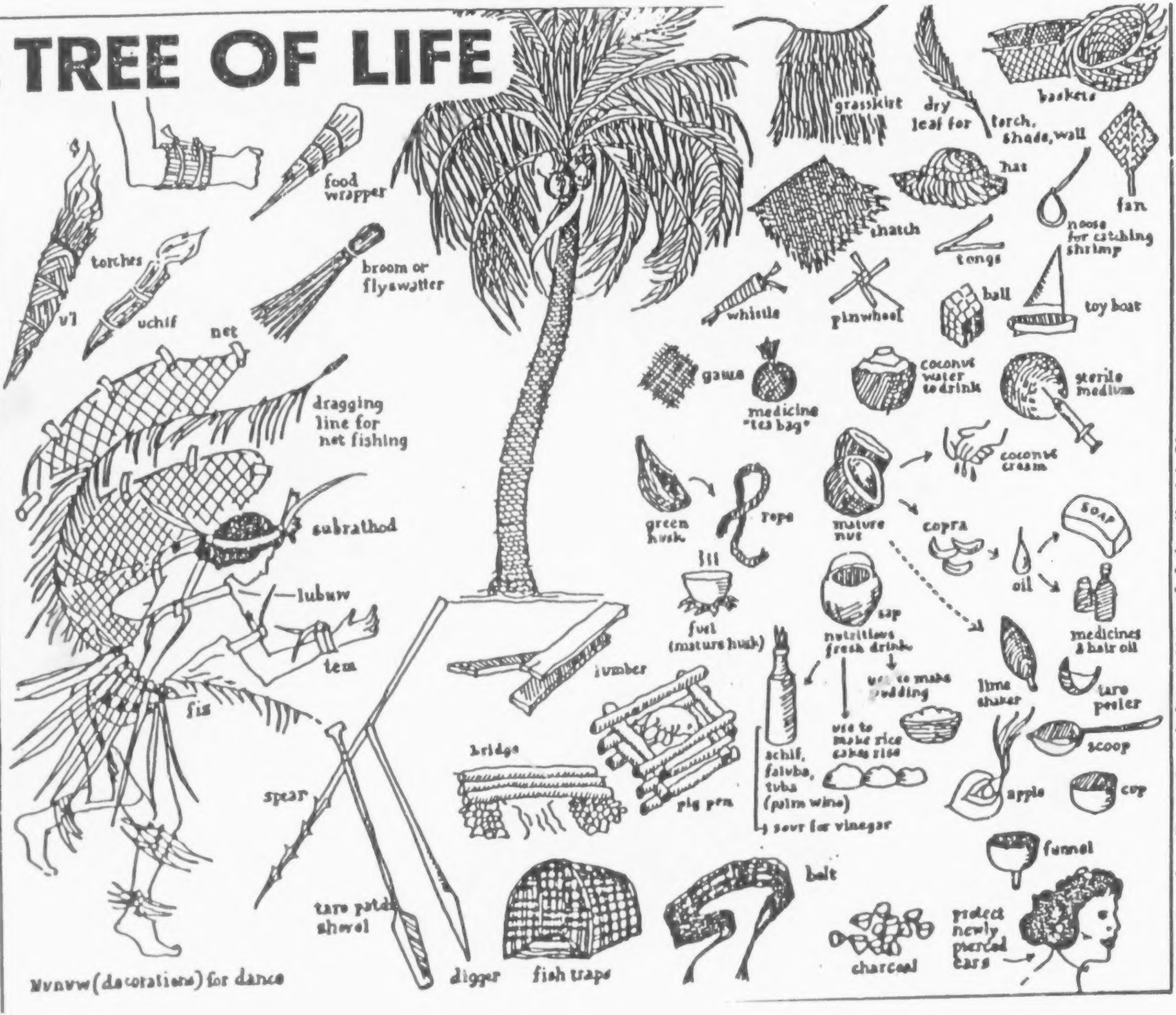
Additions to our chart of Yapese uses of coconut trees were contributed by James Mangefel including ruol to chase fish towards nets, dance decorations, splints from flower spaths, shovels from hard outer layer of trunk curved to fit around taro corms, shells to cover newly pierced ears, torches, and more, pictured to the right.

Coconut Pudding

There are many versions of coconut pudding. In general, a mixture of coconut cream, starch and sweetner are boiled, steamed, or baked. The starch may come from especially processed tubers of Tacca , chab chab; or cassava,and the amount varied to obtain a thin or thicker pudding. The recipe below uses cornstarch and produces a firm pudding.

3 cups coconut milk, 6 tablespoons cornstarch, 3-6 tablespoons sugar

Grate 4-6 coconuts, stir in about 2 cups hot water and squeeze out 3 cups coconut milk. Mix the cornstarch and sugar. Pour in a bit of the milk to make a smooth paste. Heat the rest of the coconut milk just to boiling and add the cornstarch mixture, stirring constantly until thick. Pour a 2' layer into a cake pan or mold and let cool. Cut into squares and serve on leaves.


torches
vi
uchif
food wrapper
broom or flyswatter
net
dragging line for net fishing
subrathod
lubuw
tem
fis
spear
taro patch shovel
Nvnvw (decorations) for dance
digger
bridge
lumber
fish traps
pig pen
belt
grasskirt
dry leaf for torch, shade, wall
baskets
hat
thatch
fan
noose for catching shrimp
tongs
whistle
pinwheel
ball
toy boat
gawa
medicine "tea bag"
coconut water to drink
sterile medium
green husk
rope
mature nut
coconut cream
copra
oil
soap
medicines & hair oil
fuel (mature husk)
sap
nutritious fresh drink
use to make pudding
use to make rice cakes rice
schif, faluba, tuba (palm wine)
sour for vinegar
lime shaker
taro peeler
scoop
apple
cup
funnel
charcoal
protect newly pierced ears

After Stanley Kanrad and James Mangefel by Kathi Slater-Hinden

Fig. 5. Source: Yap Almanac Calendar, 1986. Previous calendars carried more information on these and other vegetables

GARDENING FOR HEALTH,

People tend to think of vegetable gardens as rows of cabbage and other such vegetables. A luscious head of cabbage is nice to look at and crunch, but nutritionally it is inferior to some of our more easily grown local vegetables. Relative amounts of some important nutrients in "foreign" and "local" greens are shown to the right.

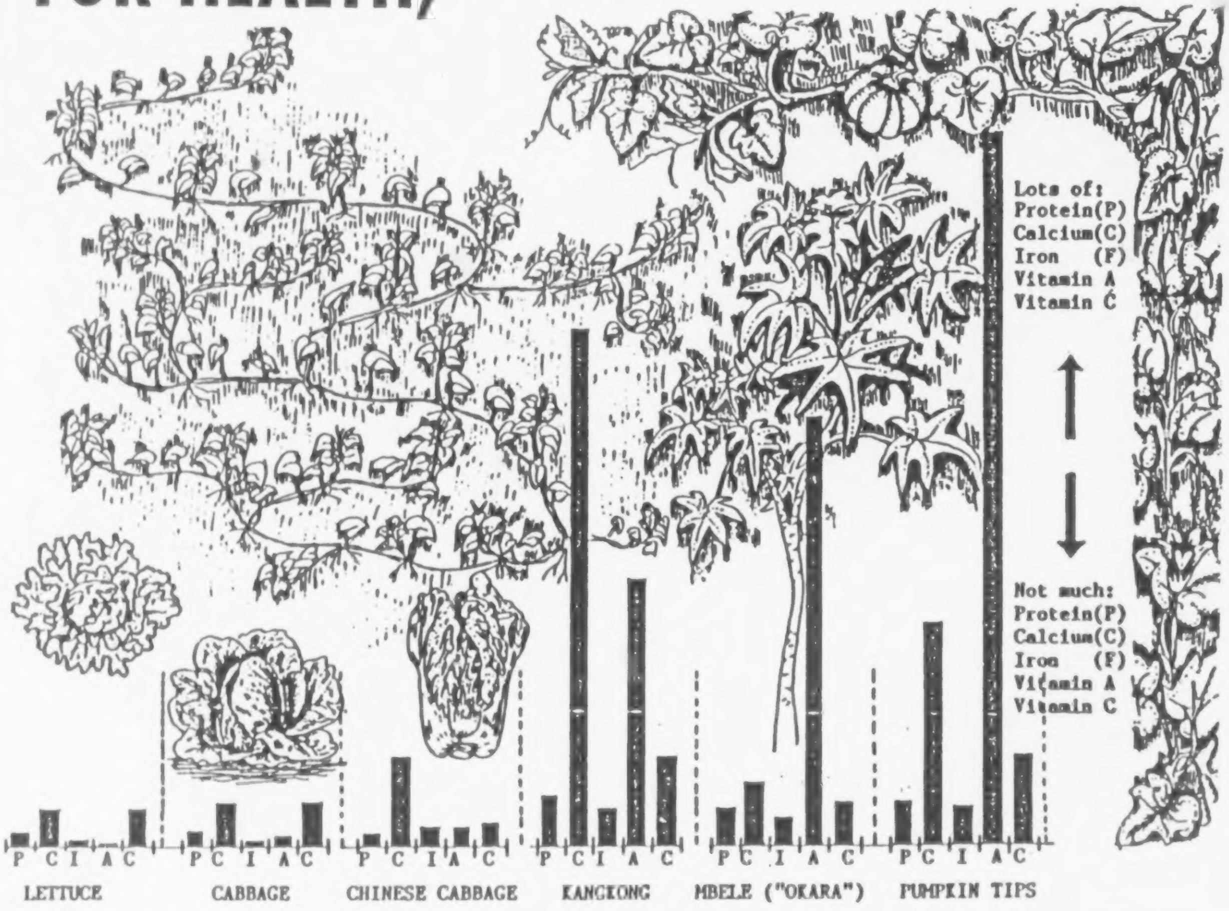
Protein is important in growth and development of the whole body.

Calcium is needed for bones, teeth, healthy blood regulation of heartbeat. A deficiency of this mineral can lead to cramps joint pains, heart palpitation, tooth decay, impared growth and irritability of nerves and muscles.

Iron is important for blood's ability to transport oxygen for all life functions. It increases resistance to stress and disease. A deficiency leads to anemia with fatigue, constipation, difficult breathing and other symptoms.

Vitamin A aids in growth and repair and also helps the body fight infections. It is needed for good eyesight & skin and useful in treating bronchial asthma and cirrhosis of the liver.

Vitamin C helps the body fight infections, speeds up healing, and is needed during stress. When lacking there may be shortness of breath & blood clots possibly related to heart attacks and stroke.



Appendix: Data on Demography

DEMOGRAPHY

Table 2. Population of the Trust Territory and the Northern Marianas by age and sex, 1973 - all persons, percentages
(De facto population by district of usual residence)

District Age Group	Total Trust Territory			Kosrae			Marshalls			Palau			Ponape			Truk			Yap			Northern Marianas		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
0-4	18.1	18.5	17.8	18.8	18.4	19.1	19.3	19.6	18.8	15.0	15.1	14.9	18.7	18.7	18.6	18.5	18.9	18.1	15.5	15.9	15.0	16.9	16.5	17.1
5-9	15.6	15.9	15.3	17.6	17.2	17.6	15.9	16.0	15.8	15.9	15.4	16.5	15.4	15.7	15.1	15.1	15.5	14.8	14.0	14.2	13.9	15.3	15.1	15.6
10-14	13.4	13.6	13.2	14.4	16.7	12.1	12.5	12.2	12.9	14.4	14.4	14.5	13.9	14.2	13.7	12.9	13.0	12.9	12.8	13.4	12.2	13.4	13.3	13.5
15-19	11.5	11.6	11.4	11.5	11.0	12.0	11.3	11.0	11.7	12.3	12.6	11.9	11.3	11.5	11.1	11.2	11.5	10.9	11.0	10.3	11.7	11.4	10.4	12.6
20-24	8.3	8.3	8.3	7.4	6.4	8.6	8.5	8.7	8.3	8.5	9.4	7.6	8.1	8.1	8.2	8.4	8.0	8.8	8.0	7.9	8.0	8.8	7.9	9.8
25-29	5.7	5.6	5.8	6.1	5.9	6.4	6.4	6.3	6.6	5.7	6.2	5.2	4.9	4.7	5.0	6.1	6.0	6.3	5.6	6.0	5.2	6.9	7.2	6.5
30-34	4.0	3.9	4.2	4.4	4.1	4.6	4.2	4.6	3.9	4.4	4.4	4.4	4.1	3.8	4.3	4.2	4.1	4.2	4.5	4.1	5.0	5.3	6.1	4.4
35-39	4.2	4.0	4.4	4.3	4.2	4.3	3.7	3.7	3.7	4.2	4.1	4.2	4.2	4.0	4.3	4.6	4.3	5.0	4.9	4.7	5.0	5.0	5.5	4.4
40-44	3.8	3.8	3.7	3.9	3.9	4.0	3.4	3.6	3.1	3.5	3.4	3.6	4.0	3.9	4.1	3.9	4.1	3.8	4.6	4.6	4.6	4.2	2.8	3.5
45-49	3.3	3.1	3.5	2.6	2.1	3.1	3.1	3.0	3.2	3.5	3.0	3.9	3.6	3.6	3.6	3.3	3.1	3.5	3.7	3.6	3.9	3.1	3.7	2.5
50-54	3.3	3.2	3.5	2.8	3.0	2.6	3.0	2.9	3.0	3.3	3.5	3.1	3.7	3.4	4.0	3.3	3.2	3.4	4.2	3.7	4.6	2.9	3.1	2.8
55-59	2.6	2.5	2.6	1.5	1.7	1.3	2.6	2.7	2.6	2.9	2.6	3.1	2.7	2.9	2.5	2.3	2.1	2.4	3.2	3.4	2.9	2.3	2.1	2.5
60-64	2.2	2.2	2.2	1.6	1.6	1.5	2.1	2.1	2.1	1.7	1.6	1.8	2.0	2.1	1.9	2.6	2.6	2.5	2.6	2.6	2.5	1.9	2.0	1.7
65-69	1.5	1.4	1.6	1.3	1.4	1.2	1.4	1.3	1.6	1.6	1.4	1.8	1.3	1.4	1.3	1.5	1.4	1.6	1.8	1.7	1.9	1.2	1.1	1.3
70-74	1.1	1.1	1.1	1.1	1.4	0.7	1.0	0.9	1.2	1.1	1.0	1.2	1.0	1.0	1.0	1.1	1.2	1.0	1.6	1.6	1.5	0.8	0.6	0.9
75 and over	1.4	1.3	1.4	0.9	0.9	0.9	1.5	1.4	1.6	2.0	1.8	2.2	1.1	1.0	1.3	1.0	1.0	1.0	2.1	2.1	2.0	0.7	0.6	0.8

Table 3.a. Estimated mid-year population of the Trust Territory and Northern Marianas by district, age-group and sex, 1970 - 1977

TTPI -Citizens

District	Sex	Age group	1970	1971	1972	1973	1974	1975	1976	1977
Trust Territory										
TT Total	Both	Total	89,700	92,430	95,160	97.600	100,760	103,870	107,000	110,180
		0 - 14	43,270	44,480	45,350	46,100	47,360	48,440	49,400	50,320
		15 - 64	42,920	44,630	46,360	47,600	49,480	51,400	53,380	55,420
		65 over	3.510	3,320	3.450	3,900	3,920	4,030	4,220	4,440
	Male	Total	45,980	47,290	48,670	49,920	51,500	53,070	54,640	56,240
		0 - 14	22,580	23,220	23,650	23,960	24,610	25,150	25,610	26,050
		15 - 64	21,670	22,530	23,410	24,040	24,990	25,970	26,980	28,020
		65 over	1,730	1,540	1,610	1,920	1,900	1,950	2,050	2,170
	Female	Total	43,720	45,140	46,490	47,680	49,260	50,800	52,360	53,940
		0 - 14	20 [illegible]	21,260	21,700	22,140	22,750	23,290	23,790	24,270
		15 - 64	21 [illegible]	22,100	22,950	23,560	24,490	25,430	26,400	27,400
		65 over	1,780	1,780	1,840	1,980	2,020	2,080	2,170	2,270
Kosrae	Both	Total	3,620	3,730	3,850	3,920	4,060	4,190	4,330	4,470
		0 - 14	1,910	1,950	1,990	2,000	2,040	2,090	2,130	2,170
		15 - 64	1,590	1,670	1,750	1,780	1,870	1,960	2,060	2,150
		65 over	120	110	120	140	150	140	140	150
	Male	Total	1,840	1,900	1,950	1,980	2,050	2,120	2,190	2,260
		0 - 14	1,020	1,040	1,040	1,050	1,070	1,080	1,090	1,100
		15 - 64	750	790	840	850	900	960	1,020	1,080
		65 over	70	70	70	80	80	80	80	80
	Female	Total	1,780	1,830	1,900	1,940	2,010	2,070	2,140	2,210
		0 - 14	890	910	950	950	970	1,010	1,040	1,070
		15 - 64	840	880	900	930	970	1,000	1,040	1,070
		65 over	50	40	50	60	70	60	60	70
Marshalls	Both	Total	22,080	22,860	23,530	23,970	24,790	25,580	26,340	27,100
		0 - 14	10,860	11,240	11,520	11,580	11,950	12,260	12,540	12,790
		15 - 64	10,340	10,730	11,110	11,430	11,860	12,320	12,770	13,240
		65 over	880	890	900	960	980	1,000	1,030	1,070
	Male	Total	11,310	11,710	12,040	12,250	12,670	13,070	13,450	13,830
		0 - 14	5,630	5,850	6,000	5,990	6,200	6,370	6,510	6,640
		15 - 64	5,260	5,450	5,630	5,810	6,020	6,240	6,460	6,690
		65 over	420	410	410	450	450	460	480	500
	Female	Total	10,770	11,150	11,490	11,720	12,120	12,510	12,890	13,270
		0 - 14	5,230	5,390	5,520	5,590	5,750	5,890	6,030	6,150
		15 - 64	5,070	5,280	5,480	5,620	5,840	6,080	6,310	6,550
		65 over	470	480	490	510	530	540	550	570

Source: Statistical Yearbook I(1)

Table 3.a. Estimated mid-year population of the Trust Territory and the Northern Marianas by agegroup, sex and district, 1970 - 1977 TTPI - citizens only - continued

District	Sex	Age group	1970	1971	1972	1973	1974	1975	1976	1977
Palau	Both	Total	11,290	11,540	11,830	12,090	12,430	12,780	13,150	13,520
		0 - 14	5,440	5,460	5,480	5,630	5,680	5,740	5,820	5,900
		15 - 64	5,230	5,490	5,780	5,860	6,140	6,430	6,730	7,030
		65 over	620	590	570	600	610	610	600	590
	Male	Total	5,810	5,940	6,090	6,210	6,390	6,560	6,750	6,930
		0 - 14	2,820	2,830	2,830	2,910	2,940	2,960	3,000	3,030
		15 - 64	2,700	2,830	2,990	3,020	3,170	3,320	3,480	3,630
		65 over	290	280	270	280	280	280	270	270
	Female	Total	5,480	5,600	5,740	5,880	6,040	6,220	6,400	6,590
		0 - 14	2,620	2,630	2,650	2,720	2,740	2,780	2,820	2,870
		15 - 64	2,530	2,660	2,790	2,840	2,970	3,110	3,250	3,400
		65 over	330	310	300	320	330	330	330	320
Ponape	Both	Total	17,390	17,980	18,490	18,800	19,440	20,030	20,610	21,190
		0 - 14	8,620	8,870	8,970	9,040	9,280	9,450	9,580	9,690
		15 - 64	8,190	8,550	8,940	9,110	9,500	9,890	10,320	10,740
		65 over	580	560	580	650	660	690	710	760
	Male	Total	8,910	9,230	9,490	9,620	9,950	10,250	10,540	10,830
		0 - 14	4,480	4,600	4,650	4,680	4,800	4,880	4,940	4,990
		15 - 65	4,150	4,340	4,540	4,620	4,820	5,020	5,240	5,460
		65 over	280	290	300	320	330	350	360	380
	Female	Total	8,840	8,750	9,000	9,180	9,490	9,780	10,070	10,360
		0 - 14	4,140	4,270	4,320	4,360	4,480	4,570	4,640	4,700
		15 - 64	4,040	4,210	4,400	4,490	4,680	4,870	5,080	5,280
		65 over	300	270	280	330	330	340	350	380
Truk	Both	Total	28,540	29,350	30,340	31,050	31,970	33,040	34,120	35,220
		0 - 14	13,540	14,000	14,340	14,580	15,030	15,430	15,810	16,150
		15 - 64	14,070	14,530	14,990	15,350	15,910	16,460	17,030	17,650
		65 over	930	820	1,010	1,120	1,030	1,150	1,150	1,420
	Male	Total	14,570	14,970	15,480	15,800	16,210	16,770	17,330	17,890
		0 - 14	7,070	7,310	7,490	7,590	7,820	8,030	8,220	8,390
		15 - 64	7,030	7,250	7,460	7,650	7,930	8,200	8,480	8,790
		65 over	470	410	530	560	460	540	630	710
	Female	Total	13,970	14,380	14,860	15,250	15,760	16,270	16,790	17,330
		0 - 14	6,470	6,690	6,850	6,990	7,210	7,400	7,590	7,760
		15 - 64	7,040	7,280	7,530	7,700	7,980	8,260	8,550	8,860
		65 over	460	410	480	560	570	610	650	710
Yap	Both	Total	7,020	7,180	7,370	7,560	7,770	7,990	8,230	8,480
		0 - 14	3,040	3,080	3,140	3,270	3,340	3,410	3,510	3,590
		15 - 64	3,580	3,710	3,840	3,870	4,010	4,150	4,290	4,440
		65 over	400	390	390	420	440	430	430	450
	Male	Total	3,570	3,670	3,760	3,840	3,950	4,060	4,180	4,300
		5 - 14	1,630	1,650	1,680	1,730	1,770	1,800	1,840	1,870
		15 - 64	1,730	1,800	1,870	1,890	1,960	2,040	2,120	2,200
		65 over	210	210	210	220	220	220	220	230
	Female	Total	3,450	3,520	3,610	3,720	3,820	3,930	4,050	4,180
		0 - 14	1,410	1,430	1,460	1,540	1,570	1,610	1,670	1,720
		15 - 64	1,850	1,910	1970	1,980	2,050	2,110	2,170	2,240
		65 over	190	180	180	200	200	210	210	220
Northern Mariana Islands	Both	Total	12,920	13,320	13,760	14,220	14,690	15,180	15,710	16,260
		0 - 14	5,970	6,100	6,240	6,480	6,670	6,840	7,040	7,250
		15 - 64	6,640	6,900	7,170	7,360	7,640	7,930	8,230	8,530
		65 over	310	320	350	380	380	410	440	480
	Male	Total	6,760	6,950	7,170	7,430	7,650	7,900	8,160	8,450
		0 - 14	3,090	3,160	3,230	3,340	3,440	3,530	3,620	3,720
		15 - 64	3,540	3,660	3,790	3,920	4,050	4,190	4,340	4,500
		65 over	130	130	150	170	160	180	200	230
	Female	Total	6,160	6,370	6,590	6,790	7,040	7,280	7,550	7,810
		0 - 14	2,880	2,940	3,010	3,140	3,230	3,310	3,420	3,530
		15 - 64	3,100	3,240	3,380	3,440	3,590	3,740	3,890	4,030
		65 over	180	190	200	210	220	230	240	250

Estimates are based on the 1973 Population Census. The cohort-component method of population projection is used to obtain the estimates (computer package program provided by the Population Council, New York).

The total Trust Territory population includes about two hundred persons in the 1973 Census whose district of residence was unknown. Therefore, the districts do not exactly add up to the Total.

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Table 3.b Projected mid-year population of the Trust Territory and Northern Marianas, by age, sex and district, 1978 - 1982

(TTPI citizens only)

District	Sex	Age group	1978	1979	1980	1981	1982
Trust Territory Total	Both sexes	Total	113,480	116,960	120,840	125,020	129,460
		0 - 14	51,240	52,350	53,770	55,430	57,300
		15 - 64	57,550	59,750	62,040	64,390	66,810
		65 over	4,690	4,860	5,030	5,200	5,350
	Male	Total	57,900	59,630	61,590	63,700	65,950
		0 - 14	26,480	27,010	27,710	28,530	29,470
		15 - 64	29,110	30,240	31,410	32,620	33,860
		65 over	2,310	2,380	2,470	2,550	2,620
	Female	Total	55,580	57,330	59,250	61,320	63,510
		0 - 14	24,760	25,340	26,060	26,900	27,830
		15 - 64	28,440	29,510	30,630	31,770	32,950
		65 over	2,380	2,480	2,560	2,650	2,730
Kosrae	Both sexes	Total	4,610	4,780	4,940	5,110	5,300
		0 - 14	2,200	2,240	2,290	2,340	2,410
		15 - 64	2,260	2,380	2,490	2,610	2,730
		65 over	150	160	160	160	160
	Male	Total	2,330	2,420	2,500	2,580	2,680
		0 - 14	1,110	1,130	1,150	1,180	1,920
		15 - 64	1,140	1,200	1,250	1,310	1,370
		65 over	80	90	90	90	90
	Female	Total	2,280	2,360	2,440	2,530	2,620
		0 - 14	1,090	1,110	1,140	1,160	1,190
		15 - 64	1,120	1,180	1,240	1,300	1,360
		65 over	70	70	70	70	70
Marshalls	Both sexes	Total	27,880	28,720	29,670	30,710	31,840
		0 - 14	13,030	13,270	13,600	13,990	14,440
		15 - 64	13,750	14,290	14,860	15,460	16,100
		65 over	1,120	1,160	1,210	1,260	1,300
	Male	Total	14,220	14,640	15,120	15,640	16,220
		0 - 14	6,750	6,880	7,040	7,230	7,460
		15 - 64	6,940	7,210	7,500	7,810	8,140
		65 over	530	550	580	600	620
	Female	Total	13,660	14,080	14,550	15,070	15,620
		0 - 14	6,260	6,390	6,560	6,760	6,980
		15 - 64	6,810	7,080	7,360	7,650	7,960
		65 over	590	610	630	660	680
Palau	Both sexes	Total	13,910	14,320	14,800	15,320	15,870
		0 - 14	5,990	6,110	6,260	6,440	6,660
		15 - 64	7,330	7,630	7,950	8,260	8,550
		65 over	590	580	590	620	660
	Male	Total	7,130	7,350	7,590	7,860	8,130
		0 - 14	3,070	3,130	3,210	3,310	3,420
		15 - 64	3,790	3,940	4,100	4,260	4,400
		65 over	270	280	280	290	310
	Female	Total	6,780	6,970	7,210	7,460	7,740
		0 - 14	2,920	2,980	3,050	3,130	3,240
		15 - 64	3,540	3,690	3,850	4,000	4,150
		65 over	320	300	310	330	350
Ponape	Both sexes	Total	21,780	22,420	23,140	23,920	24,770
		0 - 14	9,820	9,990	10,250	10,560	10,930
		15 - 64	11,160	11,580	12,000	12,430	12,870
		65 over	800	850	890	930	970
	Male	Total	11,130	11,440	11,800	12,200	12,630
		0 - 14	5,060	5,130	5,260	5,420	5,600
		15 - 64	5,670	5,880	6,090	6,310	6,540
		65 over	400	430	450	470	490
	Female	Total	10,650	10,980	11,340	11,720	12,140
		0 - 14	4,760	4,860	4,990	5,140	5,330
		15 - 64	5,490	5,700	5,910	6,120	6,340
		65 over	400	420	440	460	470

Table 3.b. Projected mid-year population of the Trust Territory and Northern Marianas by age, sex and district, 1978 - 1982 (TTPI citizens only) - continued.

District	Sex	Age group	1978	1979	1980	1981	1982
Truk	Both sexes	Total	36,350	37,400	38,650	40,010	41,460
		0 - 14	16,500	16,910	17,410	17,980	18,590
		15 - 64	18,280	18,960	19,670	20,410	21,180
		65 over	1,570	1,530	1,570	1,620	1,690
	Male	Total	18,470	18,960	19,580	20,280	21,020
		0 - 14	8,560	8,760	9,000	9,280	9,570
		15 - 64	9,110	9,470	9,840	10,240	10,650
		65 over	800	730	740	760	800
	Female	Total	17,880	18,440	19,070	19,730	20,440
		0 - 14	7,940	8,150	8,410	8,700	9,020
		15 - 64	9,170	9,490	9,830	10,170	10,530
		65 over	770	800	830	860	890
Yap	Both sexes	Total	8,750	9,020	9,320	9,630	9,940
		0 - 14	3,690	3,810	3,930	4,080	4,230
		15 - 64	4,590	4,730	4,890	5,040	5,190
		65 over	470	480	500	510	520
	Male	Total	4,430	4,560	4,710	4,870	5,020
		0 - 14	1,910	1,970	2,030	2,110	2,180
		15 - 64	2,280	2,350	2,430	2,500	2,580
		65 over	240	240	250	260	260
	Female	Total	4,320	4,460	4,610	4,760	4,920
		0 - 14	1,780	1,840	1,900	1,970	2,050
		15 - 64	2,310	2,380	2,460	2,540	2,610
		65 over	230	240	250	250	260
Northern Marianas	Both sexes	Total	16,840	17,420	18,060	18,730	19,420
		0 - 14	7,460	7,700	7,970	8,260	8,580
		15 - 64	8,860	9,180	2,520	9,870	10,210
		65 over	520	540	570	600	630
	Male	Total	8,740	9,030	9,350	9,700	10,040
		0 - 14	3,820	3,940	4,080	4,230	4,390
		15 - 64	4,660	4,830	5,000	5,180	5,350
		65 over	260	260	270	290	300
	Female	Total	8,100	8,390	8,710	9,030	9,380
		0 - 14	3,640	3,760	3,890	4,030	4,190
		15 - 64	4,200	4,350	4,520	4,690	4,860
		65 over	260	280	300	310	330

Table 4: Number of registered live births, deaths and infant deaths by sex and by month of events, 1976.

	TRUST TERRITORY a/									NORTHERN MARIANA ISLANDS								
	Live Births			Total Deaths			Of Which Infant Deaths b/			Live Births			Total Deaths			Of Which Infant Deaths b/		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
January	154	143	297	21	23	44	4	7	11	30	29	59	7	3	10	2	1	3
February	153	132	285	22	22	44	4	5	9	20	21	41	4	5	9	2	-	2
March	161	156	317	25	16	41	4	4	8	27	26	53	6	2	8	-	-	-
April	132	131	263	19	13	32	2	1	3	21	18	39	5	3	8	-	-	-
May	142	136	278	19	23	42	3	2	5	21	30	51	3	2	5	-	-	-
June	147	110	257	18	14	32	-	2	2	23	30	53	6	3	9	-	-	-
July	141	132	273	21	6	27	1	1	2	22	18	40	3	3	6	1	-	1
August	140	142	282	28	15	43	4	6	10	25	17	42	1	4	5	-	1	1
September	153	134	287	24	17	41	2	1	3	28	15	43	1	3	4	-	-	-
October	166	124	290	18	8	26	4	2	6	25	25	50	7	8	15	-	-	-
November	151	127	278	25	12	37	5	3	8	23	24	47	6	1	7	2	1	3
December	146	149	295	31	8	39	4	-	4	36	19	55	5	2	7	1	-	1
Total	1786	1616	3402	271	177	448	37	34	71	301	272	573	54	39	93	8	3	11

a/ Excluding 12 births and 3 deaths which occurred to expatriate residents of the Kwajalein Missile Range facilities.

b/ Deaths of children under 1 year of age, excluding fetal deaths.

NOTE: There is a varying degree of under-reporting of vital events. Registration is limited largely to occurrences in Health Department facilities (hospitals, dispensaries, clinics) and the degree of under-registration therefore largely depends on the accessibility of these facilities to the residents of the areas where they are located. See also note to Table 8 on page 9.

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Table 5. Number of registered live births, deaths and infant deaths in the Trust Territory and Northern Marianas by district of residence (of mother) and sex, 1976

Sex	District						Trust Territory TOTAL	Northern Marianas TOTAL
	Kosrae	Marshalls	Palau	Ponape	Truk	Yap		
a. Live births								
Both sexes	86	1,092	375	844	741	264	3,402	573
Male	42	565	193	440	411	135	1,786	301
Female	44	527	182	404	330	129	1,616	272
b. Total Deaths								
Both sexes	5	102	73	104	100	64	448	93
Male	5	61	45	65	57	38	271	54
Female	-	41	28	39	43	26	177	39
c. Infant Deaths a)								
Both sexes	-	19	9	21	16	6	71	11
Male	-	10	4	9	12	2	37	8
Female	-	9	5	12	4	4	34	3

a) Deaths of children under 1 year of age, excluding fetal deaths

Table 6. Live births in the Trust Territory and Northern Marianas by district and age group of mother, 1976
(Percentages)

Age group of Mother	District						Trust Territory TOTALS	Northern Marianas TOTALS
	Kosrae	Marshalls	Palau	Ponape	Truk	Yap		
Under 15	-	0.1	0.3	-	0.1	-	0.1	0.7
15 - 19	8.1	19.1	13.0	16.1	11.5	17.0	15.6	18.4
20 - 24	34.9	36.9	44.8	35.6	30.2	33.3	35.6	36.3
25 - 29	26.7	25.7	24.5	23.5	27.7	26.9	25.6	26.7
30 - 34	10.5	11.0	10.7	12.8	17.5	11.4	12.8	10.3
35 - 39	11.6	5.3	5.3	8.4	9.1	7.2	7.2	5.1
40 - 44	8.2	1.8	1.1	3.4	3.2	3.8	2.8	2.3
45 - 49	-	0.1	0.3	0.2	0.7	0.4	0.3	0.2
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

See note to Table 8 on page 9.

Table 7. Deaths in the Trust Territory and Northern Marianas by district, sex and age group, 1976
(Percentages)

District	Sex	Age Group										
		Under 1	1 - 4	5 - 9	10 - 19	20 - 29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 and Over
Kosrae	Both sexes	-	-	-	20.0	40.0	-	-	40.0	-	-	-
	Male	-	-	-	20.0	40.0	-	-	40.0	-	-	-
	Female	-	-	-	-	-	-	-	-	-	-	-
Marshalls	Both sexes	18.6	9.8	3.9	3.0	3.9	2.0	7.8	10.8	17.7	16.7	3.9
	Male	16.4	8.2	1.6	4.9	6.6	1.6	8.2	9.9	18.0	18.0	6.6
	Female	22.0	12.2	7.3	-	-	2.4	7.3	12.2	17.1	19.5	-
Palau	Both sexes	12.3	5.5	1.4	4.1	8.2	6.9	6.8	5.5	12.3	23.3	13.7
	Male	8.9	4.4	-	4.4	11.1	11.1	6.7	8.9	11.1	24.5	8.9
	Female	17.9	7.1	3.6	3.6	3.6	-	7.1	-	14.3	21.4	21.4
Ponape	Both sexes	20.2	5.8	2.9	2.9	8.6	7.7	5.8	10.6	13.4	11.5	10.6
	Male	13.9	6.1	4.6	3.1	7.7	7.7	6.1	10.8	18.4	10.8	10.8
	Female	30.8	5.1	-	2.6	10.2	7.7	5.1	10.3	5.1	12.8	10.3
Truk	Both sexes	16.0	7.0	4.0	5.0	3.0	4.0	8.0	19.0	12.0	14.0	8.0
	Male	21.1	5.3	1.7	1.7	1.7	3.5	12.3	21.1	15.8	10.5	5.3
	Female	9.3	9.3	7.0	9.3	4.6	4.7	2.3	16.3	7.0	18.6	11.6
Yap	Both sexes	9.4	4.7	3.1	-	3.1	4.7	3.1	15.5	18.8	18.8	18.8
	Male	5.3	5.3	2.6	-	5.3	7.9	2.6	13.1	18.4	23.7	15.8
	Female	15.4	3.8	3.8	-	-	-	3.8	19.2	19.2	11.5	23.1
Total Trust Territory	Both sexes	15.9	6.7	3.1	3.4	5.8	4.9	6.5	12.7	14.5	16.5	10.0
	Male	13.7	5.9	2.2	3.3	7.0	5.9	7.4	13.3	16.2	16.2	8.9
	Female	19.2	7.9	4.5	3.4	3.9	3.4	5.1	11.9	11.9	16.9	11.9
Northern Marianas	Both sexes	11.8	4.3	1.1	3.2	2.1	1.1	14.0	10.7	20.4	18.3	13.0
	Male	14.8	5.5	-	1.9	1.9	-	20.4	5.5	18.5	22.2	9.3
	Female	7.7	2.6	2.6	5.1	2.6	2.6	5.1	17.9	23.1	12.8	17.9

Table 5. Live births in the Trust Territory and Northern Marianas by district and age-group of mother, 1977.
(Percentages)

Age-group of mother	District						Total Trust Territory	Northern Marianas
	Kosrae	Marshalls	Palau	Ponape	Truk	Yap		
Under 15	0.0	0.2	0.0	0.0	0.3	0.3	0.1	0.2
15 - 19	6.4	17.5	19.5	14.6	12.0	16.6	15.5	17.2
20 - 24	32.7	36.0	33.4	33.8	33.4	33.2	34.3	35.5
25 - 29	22.7	26.0	28.5	26.7	26.7	24.4	26.5	26.7
30 - 34	19.2	11.7	11.3	12.5	15.1	10.5	12.6	13.8
35 - 39	11.8	5.7	5.2	7.0	8.9	10.9	7.3	4.2
40 - 44	5.4	2.2	1.5	4.8	3.1	3.4	3.2	2.4
45 - 49	1.8	0.1	0.3	0.4	0.5	0.7	0.4	0.0
50 over	0.0	0.0	0.3	0.2	0.0	0.0	0.1	0.0
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

See note to Table 8.

Table 6. Deaths in the Trust Territory and Northern Marianas by district , sex and age-group, 1977.
(Percentages)

Age-group sex	District						Total Trust Territory	Northern Marianas
	Kosrae	Marshalls	Palau	Ponape	Truk	Yap		
Both sexes								
Under 1	7.7	30.1	15.0	24.0	16.7	16.1	22.1	24.4
1 - 4	30.7	13.8	6.7	5.9	16.7	4.9	10.5	2.4
5 - 9	0.0	0.6	3.3	1.3	1.0	0.0	1.1	1.2
10 - 19	7.7	3.0	10.0	3.3	6.2	2.5	4.4	2.4
20 - 19	7.7	5.4	16.7	5.9	6.2	3.7	6.7	1.2
30 - 39	15.4	2.4	5.0	2.6	2.1	0.0	2.6	6.1
40 - 49	7.7	3.0	3.3	5.9	6.3	4.9	4.7	12.2
50 - 59	0.0	11.5	13.3	9.1	11.5	6.2	10.0	14.6
60 - 69	15.4	11.5	6.7	16.9	13.5	21.0	14.2	19.5
70 - 79	7.7	11.5	11.7	16.2	10.4	16.0	13.2	7.3
80 over	0.0	7.2	8.3	9.1	9.4	24.7	10.6	8.5
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Male								
Under 1	9.1	35.1	15.8	18.2	19.0	17.1	22.6	21.6
1 - 4	36.3	10.3	7.9	5.7	13.8	8.6	10.1	2.0
5 - 9	0.0	1.0	2.6	2.3	0.0	0.0	1.2	0.0
10 - 19	9.1	5.2	10.5	4.5	10.3	5.7	6.7	3.9
20 - 19	9.1	4.1	21.0	9.1	8.6	5.7	8.6	0.0
30 - 39	18.2	1.0	2.6	3.4	3.4	0.0	2.8	9.8
40 - 49	0.0	4.1	2.6	5.7	6.9	8.6	5.2	17.6
50 - 59	0.0	10.3	7.9	10.2	10.3	5.7	9.2	11.8
60 - 69	9.1	12.4	5.3	18.2	12.1	22.9	14.1	19.6
70 - 79	9.1	9.3	13.2	15.9	10.3	8.6	11.6	9.8
80 over	0.0	7.2	10.5	6.8	5.2	17.1	7.9	3.9
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Female								
Under 1	0.0	23.2	13.6	31.8	13.2	15.2	21.4	29.0
1 - 4	0.0	18.9	4.6	6.1	21.0	2.2	11.1	3.2
5 - 9	0.0	0.0	4.6	0.0	2.6	0.0	0.8	3.2
10 - 19	0.0	0.0	9.1	1.5	0.0	0.0	1.3	0.0
20 - 19	0.0	7.2	9.1	1.5	2.6	2.2	4.1	3.2
30 - 39	0.0	4.3	9.1	1.5	0.0	0.0	2.5	0.0
40 - 49	50.0	1.5	4.5	6.1	5.3	2.2	4.1	3.2
50 - 59	0.0	13.0	22.7	7.6	13.2	6.5	11.1	19.4
60 - 69	50.0	10.1	9.1	15.1	15.8	19.6	14.4	19.4
70 - 79	0.0	14.5	9.1	16.7	10.5	21.7	15.2	3.2
80 over	0.0	7.3	4.5	12.1	15.8	30.4	14.0	16.2
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Statistical Yearbook I (3) 1978

Table 3.b. Projected mid-year population of the Trust Territory and Northern Marianas by district, agegroup and sex, 1979 - 1985, 1990 & 2000.
TTPI Citizens

District	Sex	Agegroup	1979	1980	1981	1982	1983	1984	1985	1990	2000
Trust Territory											
Total TTPI	Both	Total	116,960	120,840	125,020	129,460	134,150	139,060	144,090	171,760	242,210
		0 - 14	52,350	53,770	55,430	57,300	59,360	61,510	63,690	76,850	110,460
		15 - 64	59,750	62,040	64,390	66,810	69,300	71,860	74,520	87,990	123,740
		65 over	4,860	5,030	5,200	5,350	5,490	5,690	5,880	6,920	8,010
	Male	Total	59,630	61,580	63,700	65,950	68,340	70,830	73,380	87,390	123,020
		0 - 14	27,010	27,710	28,530	29,470	30,510	31,590	32,670	39,280	56,470
		15 - 64	30,240	31,410	32,620	33,860	35,150	36,480	37,870	44,820	62,820
		65 over	2,380	2,460	2,550	2,620	2,680	2,760	2,840	3,290	3,730
	Female	Total	57,330	59,260	61,320	63,510	65,810	68,230	70,710	84,370	119,190
		0 - 14	25,340	26,060	26,900	27,830	28,850	29,920	31,020	37,570	53,990
		15 - 64	29,510	30,630	31,770	32,950	34,150	35,380	36,650	43,170	60,920
		65 over	2,480	2,570	2,650	2,730	2,810	2,930	3,140	3,630	4,380
Kosrae	Both	Total	4,780	4,940	5,110	5,300	5,490	5,680	5,890	7,100	10,190
		0 - 14	2,240	2,290	2,340	2,410	2,480	2,560	2,650	3,220	4,710
		15 - 64	2,380	2,490	2,610	2,730	2,850	2,970	3,080	3,680	5,190
		65 over	160	160	160	160	160	150	160	200	290
	Male	Total	2,420	2,490	2,580	2,680	2,770	2,860	2,970	3,580	5,150
		0 - 14	1,130	1,150	1,180	1,920	1,260	1,300	1,350	1,650	2,410
		15 - 64	1,200	1,250	1,310	1,370	1,420	1,480	1,540	1,830	2,610
		65 over	90	90	90	90	90	80	80	100	130
	Female	Total	2,360	2,450	2,530	2,620	2,720	2,820	2,920	3,520	5,040
		0 - 14	1,110	1,140	1,160	1,190	1,220	1,260	1,300	1,570	2,300
		15 - 64	1,180	1,240	1,300	1,360	1,430	1,490	1,540	1,850	2,580
		65 over	70	70	70	70	70	70	80	100	160
Marshalls	Both	Total	28,720	29,670	30,710	31,840	33,050	34,300	35,580	42,510	60,330
		0 - 14	13,270	13,600	13,990	14,440	14,940	15,460	15,960	19,140	27,740
		15 - 64	14,290	14,860	15,460	16,100	16,760	17,460	18,190	21,770	30,830
		65 over	1,160	1,210	1,260	1,300	1,350	1,380	1,430	1,600	1,760
	Male	Total	14,640	15,120	15,640	16,220	16,840	17,480	18,130	21,640	30,650
		0 - 14	6,880	7,040	7,230	7,460	7,310	7,970	8,210	9,780	14,180
		15 - 64	7,210	7,500	7,810	8,140	8,490	8,850	9,230	11,090	15,630
		65 over	550	580	600	620	650	660	690	770	840
	Female	Total	14,080	14,550	15,070	15,620	16,210	16,820	17,450	20,870	29,680
		0 - 14	6,390	6,560	6,760	6,980	7,230	7,490	7,750	9,360	13,560
		15 - 64	7,080	7,360	7,650	7,960	8,280	8,610	8,960	10,680	15,200
		65 over	610	630	660	680	700	720	740	830	920
Palau	Both	Total	14,320	14,800	15,320	15,870	16,460	17,040	17,670	21,170	29,720
		0 - 14	6,110	6,260	6,440	6,660	6,920	7,220	7,570	9,590	13,530
		15 - 64	7,630	7,950	8,260	8,550	8,840	9,110	9,360	10,730	15,240
		65 over	580	590	620	660	700	710	740	850	950
	Male	Total	7,350	7,590	7,860	8,130	8,430	8,730	9,050	10,830	15,150
		0 - 14	3,130	3,210	3,310	3,420	3,560	3,710	3,890	4,900	6,920
		15 - 64	3,940	4,100	4,260	4,400	4,550	4,690	4,810	5,520	7,810
		65 over	280	280	290	310	320	330	350	410	420
	Female	Total	6,970	7,210	7,460	7,740	8,030	8,310	8,620	10,340	14,570
		0 - 14	2,980	3,050	3,130	3,240	3,360	3,510	3,680	4,690	6,610
		15 - 64	3,690	3,850	4,000	4,150	4,290	4,420	4,550	5,210	7,430
		65 over	300	310	330	350	380	380	390	440	530
Ponape	Both	Total	22,420	23,140	23,920	24,770	25,690	26,630	27,600	32,900	46,500
		0 - 14	9,990	10,250	10,560	10,930	11,330	11,740	12,130	14,570	21,280
		15 - 64	11,580	12,000	12,430	12,870	13,350	13,840	14,370	16,950	23,560
		65 over	850	890	930	970	1,010	1,060	1,100	1,380	1,660
	Male	Total	11,440	11,800	12,200	12,630	13,100	13,580	14,070	16,730	23,600
		0 - 14	5,130	5,260	5,420	5,600	5,800	6,000	6,200	7,450	10,880
		15 - 65	5,880	6,090	6,310	6,540	6,780	7,040	7,310	8,620	11,950
		65 over	430	450	470	490	520	540	560	660	770
	Female	Total	10,980	11,340	11,720	12,140	12,590	13,050	13,530	16,170	22,900
		0 - 14	4,860	4,990	5,140	5,330	5,530	5,740	5,930	7,120	10,400
		15 - 64	5,700	5,910	6,120	6,340	6,570	6,800	7,060	8,330	11,610
		65 over	420	440	460	470	490	510	540	720	880

Source statistical yearbook II (1) 1979

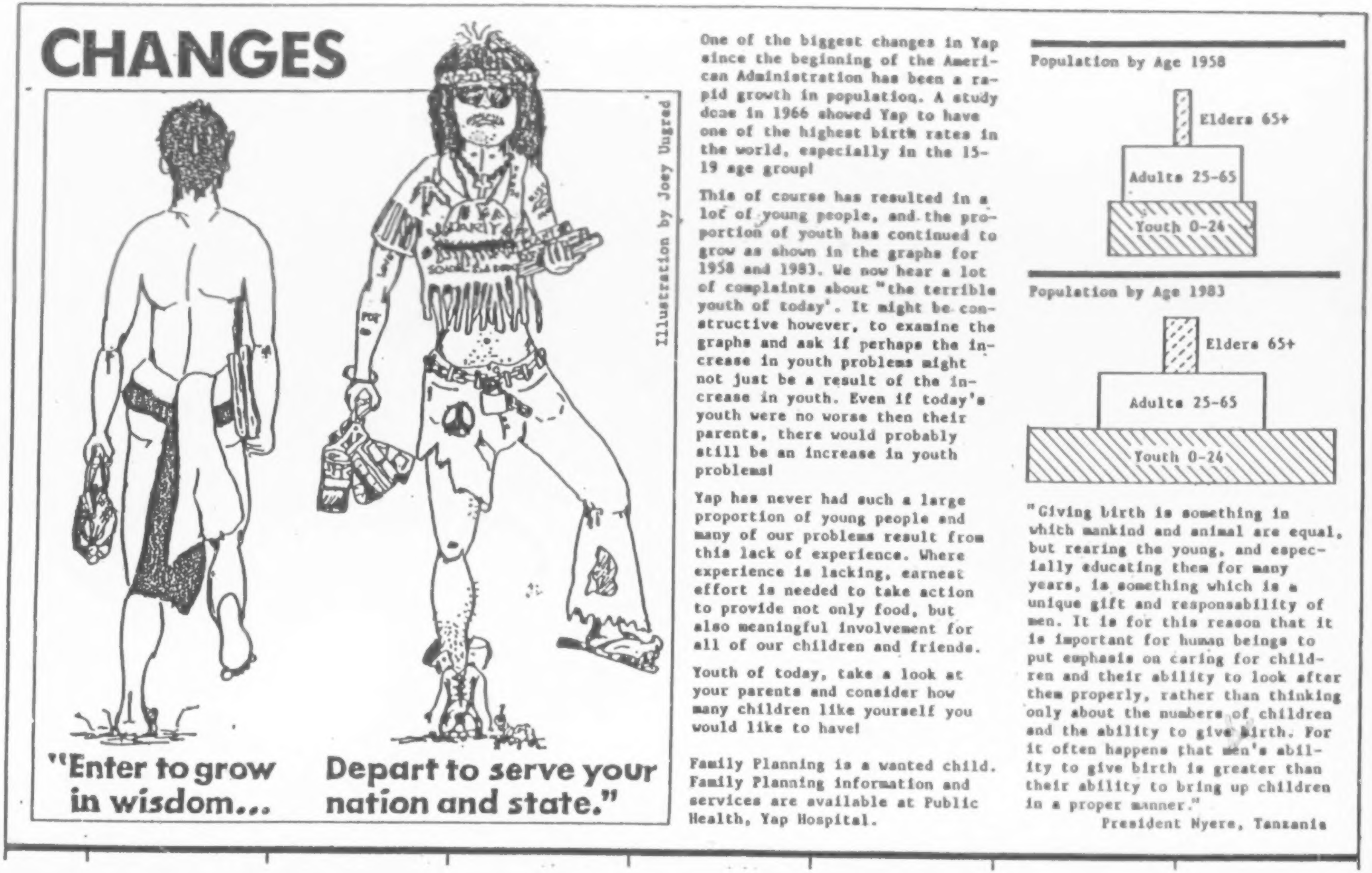
Table 3.b. Projected midyear population of the Trust Territory and Northern Marianas by district, agegroup and sex, 1979 - 1985, 1990 & 2000.
- continued
TTPI Citizens

District	Sex	Agegroup	1979	1980	1981	1982	1983	1984	1985	1990	2000
Truk	Both	Total	37,400	38,650	40,010	41,460	42,970	44,600	46,160	54,800	77,200
		0 - 14	16,910	17,410	17,980	18,590	19,250	19,920	20,570	24,470	35,060
		15 - 64	18,960	19,670	20,410	21,180	21,980	22,810	23,690	28,180	39,560
		65 over	1,530	1,570	1,620	1,680	1,740	1,870	1,900	2,150	2,580
	Male	Total	18,960	19,580	20,280	21,020	21,800	22,660	23,450	27,790	39,160
		0 - 14	8,760	9,000	9,280	9,570	9,900	10,230	10,550	12,500	17,930
		15 - 64	9,470	9,840	10,240	10,650	11,070	11,510	11,970	14,290	20,030
		65 over	730	740	760	800	830	920	930	1,000	1,200
	Female	Total	18,440	19,070	19,730	20,440	21,170	21,940	22,710	27,010	38,040
		0 - 14	8,150	8,410	8,700	9,020	9,350	9,690	10,020	11,970	17,130
		15 - 64	9,490	9,830	10,170	10,530	10,910	11,300	11,720	13,890	19,530
		65 over	800	830	860	890	910	950	970	1,150	1,380
Yap	Both	Total	9,020	9,320	9,630	9,940	10,260	10,600	10,950	12,960	17,930
		0 - 14	3,810	3,930	4,080	4,230	4,390	4,560	4,750	5,780	8,020
		15 - 64	4,730	4,890	5,040	5,190	5,340	5,500	5,640	6,520	9,170
		65 over	480	500	510	520	530	540	560	660	760
	Male	Total	4,560	4,710	4,870	5,020	5,190	5,370	5,550	6,560	9,070
		0 - 14	1,970	2,030	2,110	2,180	2,260	2,350	2,440	2,960	4,100
		15 - 64	2,350	2,430	2,500	2,580	2,660	2,740	2,820	3,290	4,630
		65 over	240	250	260	260	270	280	290	310	340
	Female	Total	4,460	4,610	4,760	4,920	5,070	5,230	5,400	6,400	8,860
		0 - 14	1,840	1,900	1,970	2,050	2,130	2,210	2,310	2,820	3,920
		15 - 64	2,380	2,460	2,540	2,610	2,680	2,760	2,820	3,230	4,540
		65 over	240	250	250	260	260	260	270	350	420
Northern Marianas	Both	Total	15,390	15,970	16,600	17,260	17,910	18,630	19,360	23,320	33,130
		0 - 14	7,010	7,250	7,530	7,830	8,150	8,490	8,870	10,910	15,210
		15 - 64	7,900	8,210	8,540	8,870	9,200	9,530	9,860	11,700	17,060
		65 over	480	510	530	560	580	610	630	710	860
	Male	Total	7,770	8,060	8,390	8,720	9,060	9,420	9,790	11,780	16,760
		0 - 14	3,580	3,700	3,850	4,000	4,160	4,340	4,530	5,580	7,770
		15 - 64	3,960	4,120	4,290	4,460	4,630	4,790	4,960	5,870	8,580
		65 over	230	240	250	260	270	290	300	330	410
	Female	Total	7,620	7,910	8,210	8,540	8,870	9,210	9,570	11,540	16,370
		0 - 14	3,430	3,550	3,680	3,830	3,990	4,150	4,340	5,330	7,440
		15 - 64	3,940	4,090	4,250	4,410	4,570	4,740	4,900	5,830	8,480
		65 over	250	270	280	300	310	320	330	380	450

Estimates are based on the 1973 Population Census. The cohort-component method of population projection is used to obtain the estimates (computer package program provided by the Population Council, New York).

The total Trust Territory population includes about two hundred persons in the 1973 Census whose district of resider . was unknown. Therefore, the districts do not exactly add up to the Total.

Popular presentation on demography from 1984 Yap Almanac Calendar


"Enter to grow in wisdom...
Depart to serve your nation and state."
Population by Age 1958
Elders 65+
Adults 25-65
Youth 0-24
Population by Age 1983
Elders 65+
Adults 25-65
Youth 0-24

CHANGES

Illustration by Joey Ungred

One of the biggest changes in Yap since the beginning of the American Administration has been a rapid growth in population. A study done in 1966 showed Yap to have one of the highest birth rates in the world, especially in the 15-19 age group!

This of course has resulted in a lot of young people, and the proportion of youth has continued to grow as shown in the graphs for 1958 and 1983. We now hear a lot of complaints about "the terrible youth of today'. It might be constructive however, to examine the graphs and ask if perhaps the increase in youth problems might not just be a result of the increase in youth. Even if today's youth were no worse then their parents, there would probably still be an increase in youth problems!

Yap has never had such a large proportion of young people and many of our problems result from this lack of experience. Where experience is lacking, earnest effort is needed to take action to provide not only food, but also meaningful involvement for all of our children and friends.

Youth of today, take a look at your parents and consider how many children like yourself you would like to have!

Family Planning is a wanted child. Family Planning information and services are available at Public Health, Yap Hospital.

"Giving birth is something in whith mankind and animal are equal, but rearing the young, and especially educating them for many years, is something which is a unique gift and responsability of men. It is for this reason that it is important for human beings to put emphasis on caring for children and their ability to look after them properly, rather than thinking only about the numbers of children and the ability to give birth. For it often happens that men's ability to give birth is greater than their ability to bring up children in a proper manner."

President Nyere, Tanzania

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APPENDIX

TRADITIONAL RESOURCE MANAGEMENT ON YAP

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Introduction.

Insular situations excite scientists, and from the time of Darwin, there has been interest in the unique species living in such isolation, and , more recently, concern for the vulnerability of island ecosystems to change. In the world of today, most islands are the home and ultimate source of support for their human inhabitants. Some of these island people have a long cultural history of surviving with their limited insular resources, sometimes in fairly dense populations. As the world's population increases, and proportional per capita resources decrease, we might take a look at the adaptive features of the cultures of island people who have, in effect, already experienced living under such conditions. This case study deals with resource use in one group of islands in the tropical Pacific.

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2. Problem Statement

Yap once had a very dense population and evolved a culture adapted to sustaining many people on limited island resources. With contact, the population decreased. It is now rising rapidly however and supplied money, energy, goods and technology are contributing to a lifestyle out of balance with resources. When aid is withdrawn, attempts to support a rising population with a more consumptive lifestyle could lead to exploitation of local resources on an unsustainable basis. It will take conscious recognition and effort to avoid resource depletion and environmental degradation which could place Yap among the obligatory dependent states of the world. The means of resource management in the past and the dilemma of resource management in the present and future is the problem dealt with in this paper.

3. Background

3.1 Geography. Yap State lies in the Western and Central Caroline Islands, and is one of the 4 Federated States of Micronesia, a political entity emerging from the Trust Territory of the Pacific Islands. The State center consists of a group of high islands of basaltic origin totaling about 38.8 square miles and known collectively as "Yap". Outer islands total 7.3 square miles and include 11 inhabited and 4 uninhabited atolls or low islands and extensive banks and shoal areas. The State covers about 400,000 square miles of ocean.

3.2 Population. The population of Yap alone is thought to have been as high as 40,000 in pre-contact times (Underwood,1969). Yapese dance chant laments a time when young betelnut fell from the trees, a poetic allusion to the fact that not only the old died, as expected, but also the young and vigorous. People blamed the misfortune on their own misbehavior. Most historians attribute the population decline to post contact epidemics. Early German reports (Thilenius, 1917), give the population of Yap as 7,464 in 1902. The population decline continued through the Japanese occupation and by 1946 there were only 2,478 people on Yap (Useem, 1946). During the American Administration of the islands however, the population has increased rapidly, and the 1973 census showed that the population of Yap had more than doubled to 5,139. The population increase in the outer islands has also been great, going from 4,760 in 1946 to 7,870 in 1973.

4. Management of Limited Resources in the Past

The precontact population of 40,000 postulated by archaeologists and anthropologists for mainland Yap give a population density of some 1,000 people per square mile! How a population anywhere near this great could have been maintained and even have energy to voyage afar for cultural tokens such as the famous stone money is remarkable.

The achievement was not easy and Yap and her people bear the signs of hard times and harsh discipline in the past. While there remain many unknowns, four factors appear to have been important in the management of resources: adaptive methods, appropriate timing of activities, energy conservation and management of people using resources.

4.1 Adaptive Methods. Most of Yap island and lagoon have been modified into an anthropocentric food production system. Most villages of Yap are situated in the narrow coastal area between mangroves and hills. The natural vegetation of these areas was probably swamp forest similar but less extensive and species rich than those to be seen in Belau. Hardly any such vegetation is present on Yap today. Low areas were deepened and connected with channels and raised paths created between them and between households and villages. Drained areas were created with this hand excavated fill, and these were planted to useful trees. With time these tree gardens became relatively self-perpetuating via the recycling of nutrients of fallen leaves as in natural forests. The forest canopy protected the soil from erosion by the often torrential downpour, and the ditches, often stone lined, directed an aerated flow of water through the system of channels and low areas. Silt and nutrients were trapped in the low areas managed as taro patches. Human energies involved largely pruning the forest to select for useful trees, transfer of excessive organic material from low areas to raised areas, and the simultaneous harvesting and replanting of the taro patches.

Areas more inland of villages were utilized for gardens of yams mixed with other crops. The making of such gardens required the opening of a "skylight" in the forest canopy. This was done during the dry part of the year when a limited area was burnt and a variety of crops planted. With the resultant ash fertilizer and beginning rains, crops generally grow fast and form a multilayered vegetative cover over the soil by the time the heavy rains come. After several harvests, these gardens are allowed to go fallow so that the canopy reforms and soil nutrients and structure is regenerated.

The seaside of most Yapese villages is lined with mangroves. These have been modified via selective logging for termite resistant wood, the creation of paths along inner margins, and the development of ponds for raising fish and retting coconut fiber in some areas. Landfill activities of the past involved the building of a rock seawall and then filling of the area inside with coral debris and sections of turf cut from seagrass beds. This activity was at least partially responsible for the coastal mangrove depressions functioning as silt traps. Most villages also built a peninsula through the mangrove fringe. This peninsula was paved with rocks and became the site of a house for fishermen and their gear, providing access to the sea and an outpost to watch for the approach of enemies. While most ecologists talk of the land building effects of mangroves, many Yapese complain about the erosive effects of mangroves and their associated fauna, especially crabs, on the paths and land built by their ancestors.

Mangroves are valued by both ecologists and Yapese as a nursery area for fish and other sea life. The rich muck also provides habitat for clams and crabs which are important as a source of protein during times when conditions are inclement for fishing, or when fishermen are not available. The coastal mangrove depression was kept clear of corals by men who utilized the area for catching mangrove crabs in traps, fishing with hand nets, and as a nearshore water route.

Beyond the coastal mangrove depression, there generally are extensive seagrass meadows. These areas, known to be highly productive by biologists, provide feeding areas for fish which retreat to deeper areas toward the mangrove or reef at low tide. These areas were generally kept clear of corals to select for a habitat for favored fish including rabbitfish (family Tuthuidae). Fishing in these areas involved the use of hand nets, and surround nets set to utilize tidal extremes. During low tide, the area provided a foraging ground for women and children. (The seeds of the seagrass Enhalus were eaten by children to assuage hunger pangs and prolong their stay in the area.) The strong fibers of Enhalus were utilized to make a fine mesh net said to have lasted for generations, and areas were protected so that this seagrass could grow especially long and thus provide long fibers for nets.

The mangroves, fishponds, coastal mangrove depressions and seagrass meadows are most important in day to day type fishing and as such functioned as an "icebox". The fishing for bigger fish in the deeper holes and channels within the lagoon involved line fishing and group net fishing which was generally reserved for special occasions when large amounts of fish were needed. One of the most notable features of Yap's reef flats are stone fishwiers. These structures are generally in the form of huge arrows pointing towards the reef, or zigzag patterns of stones along the reef edge. They are situated in relation to current patterns so that fish are directed toward the apex and diagonals of the stone walls where traps are placed. When traps are not in place, fish are directed and concentrated for but a time and can swim away with the high tide. Thus the weirs, while permanent, do not harvest continuously. Fishing beyond the reef involved sailing canoes and the use of hand lines and nets for catching flying fish.

In the past especially, fishing involved considerable ritual and taboos, including abstinence from activities of the land and association with women. Fishing efforts farthest from land required the longest isolation and men had to remain in men's houses along the shore where they and their gear would not be contaminated. The assistance of a magician was employed for special fishing expeditions and this man had to isolate himself for an even longer period.

4.2 Appropriate Timing The timing of food production and correlated social activities was quite structured and involved the services of specialists called tamerong who proclaimed the best time for different activities. Time (for agricultural activities) was reckoned by the passage of moon phases. There were 12 such "months" with a 13th called "torol" being added when needed, probably on the basis of tides in relation to day and night, position of constellations, and other seasonal phenomena.

The work of the tamerong was difficult. Yap lies near the intertropical convergence zone and the initiation of the tradewind season is irregular and the island sometimes subjected to a monsoon type pattern of torrential rainfall and a dry period. It was important to orchestrate the activities of each year to harmonize with that year's weather conditions. Predictability being limited, the activities of the tamerong also involved magic and Yap was known in times past, and to some extent even at present, for possessing powerful magic. This magic helped Yap maintain its empire extending to the the outer islands which were important conservators of navigational knowledge, having a clear horizon for viewing navigation and seasonal constellations and a greater need to voyage to other atolls, mainland Yap and even the Marianas for resources and cultural contact during favorable wind regimes. On mainland Yap, the agricultural shaman moved from one established sacred place to another with passing seasons and performed magic associated with food producing activities and a series of social celebrations associated with seasons.

The coordination of efforts resulted in a focus of group concentration. To a great extent, the Yapese food production system might be classified as "nature intensive"*4. Rather than rearrange the environment and expend great amounts of energy and chemicals, people's activities are directed to the most effective use of microhabitat and natural processes. This requires a good deal of attention to natural phenomena in order to know, for example, where to plant a yam so that its roots can gain nutrients and the tuber expand and its leaves reach the sunlight; or where to place a net to take advantage of the movements of schools of fish associated with tidal currents.

The isolation of fishermen in men's houses provided an ideal setting for the preparation of gear, a more exacting process during the days of but natural fibers and materials. It also provided a mix of fishing activity and discussion of experience that contributed to the growth of individual and group ability.

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*4 The classification "nature intensive" is intended to contrast with "Western energy, chemical and technology intensive" agriculture, and "Asian labor intensive" agriculture.

A similar situation applies to gardening and the isolation of men for fishing efforts, though couched in terms of avoiding contamination from women, probably also served to free women to become immersed in their own specialty of gardening. The tripartite tree, taro patch and mixed garden system served to assure food throughout the year despite variable weather phenomena. The time of greatest production of breadfruit was counterpoint to the period of the yam harvest, and the production of taro patches provided a back-up system (figure).

4.3 Energy Conservation. The "nature intensive" food production systems of Yap of the past appear to have minimized the expenditure of human energy per calorie of harvest. Fire was used for clearing and energy for weeding was minimized by the closure of the canopy.

The cooking of the main bulk of food was generally done but once a day with carefully tended fires. Fuels commonly utilized include the husks of coconuts and *Inocarpus* nuts and whatever wood might be available. These were largely by-products of harvested food and the food production system.

Fishing methods were largely passive. Marine transport involved the use of lightweight polled bamboo rafts and lightweight sailing canoes for fishing and nearshore travel, with specialized canoes utilized for carrying large loads and making ocean voyages.

People lived close to the most frequently utilized resources so that even energy for movement was minimized. In addition, a system of social stratification and territoriality further proscribed individual activity.

The social and territorial system of Yap seems to have managed cooperation and competition in a way which allowed for vitality but minimized the expenditure of energy. Wars were carefully managed by paramount chiefs to conclude with the killing of certain parties or achievement of other preset objectives. The currency of Yapese culture was the indeed, the calorie, and the most lavish cultural displays involve the gathering and redistribution of food, and the showing of manpower and the achievements of manpower. Tokens of such achievement, such as golden turmeric powder, woven "bagi", and stone money were largely used , not for purchases per se, but for social interaction and keeping the peace.

4.4 Management of People Using Resources. Resources can only be managed if there is a way to regulate people's use of these resources. The social organization of Yap provided for such regulation as a result of social stratification, territoriality, resource apportionment, limitations on harvest, effective sanctions and group spirit.

4.4.1. Social Stratification. It is said on Yap that people come and go, but the land remains forever. Parcels of land have names associated with them and these names are conferred on appropriate people. These lands and their associated marine areas and people are ranked. There are 3 paramount groups of equal rank, each with a series of lesser ranks subject to their request, having specialized functions. The highest ranks are chiefs called "Pilung", or "voice of the people". This group organizes the activities of their people for the good of the community and applies sanctions when necessary. The commands of chiefs were reinforced by their shamen. The group as a whole was protected by a warrior class which was somewhat privileged by virtue of the danger of their function. Other groups served as artisans, and the least influential group had no land of their own and provided services in return for the privilege of living on land and receiving protection. The villages of this last group were generally located inland in the past. By 1966 however, Underwood (1969) reports that the population distribution on Yap was more related to favorable environmental conditions than to class membership. It seems likely that the population and living situation of the lowest group fluctuated with population density, living conditions being least favorable when proportional resources were most limited. As such, the caste system probably provided a valve for population overflow by defining who would survive during times of extreme hardship.

4.4.2 Territoriality All land on Yap was, and to a large extent still is privately owned and subject to a complex land tenure system. In general lands were inherited patrilineally but tended by women and inherited by their children, thus giving some rights to the matrilineal line. Fathers could expect service from sons in return for land eventually, and women were assured the use of their husband's land subject to their children and good behavior. Land ownership involved multiple rights of use and one piece of land might belong to one person but be subject to the consent of another, be lived on by a third party, and harvested by a fourth. This complex system of land control resulted in considerable diversity in management while preventing any individual from making widespread changes to large pieces of land.

Limited areas were designated for collective use by specific groups such as chief's houses, men's houses, and women's menstrual houses. Main paths were used collectively but even here there was often a separation of women's and men's paths. Areas between villages were designated as playgrounds and here children could play and make noise. Otherwise the peace of the village was not to be disturbed.

4.4.3. Resource Apportionment. The harvests of group fishing efforts are distributed according to appropriate patterns. Certain fish, the first fish of the season, or large fish caught in traps must be presented to appropriate people.

The most striking examples of resource apportionment are the reservation of certain species to certain groups. Throughout Yap State, turtles are chiefly food. Anyone catching a turtle presented it to a chief who would divide it in an appropriate manner. Even the specific parts of the turtle were destined to go to particular people. Fruit bats and eels were other resources limited to a particular group, though because this group is not so socially influential, the ban takes the form of the items being distasteful to other classes. (In other areas of the Pacific such as Tonga however, fruit bats were reserved for chiefs. The implication would seem to be that certain species are culturally recognized as being a limited resource.)

4.4.4. Limiting Harvests. Harvests are sometimes limited by the placing of a restriction on the use of an area. This might be done for a number of reasons such as prohibiting harvesting from the lands of a person who died for a period after their death. On other occasions a fishing area might be put off limits until fish are again large and plentiful.

Other restrictions were more subtle. An individual making an especially large catch generally did not go fishing again right away as it was considered bad to harvest too much at once. Also, luck in fishing should be shared rather than used for one's own benefit.

Some fishing areas were owned so that permission was required from the overseer to fish there. Many fishing methods were the perogative of certain individuals. Fishing was a male activity and men involved in group fishing were assembled according to cultural relationships. Large group efforts were generally requested by chiefs for special occasions of the community.

Yapese of the past did not trespass on the property, resources or rights of others. The seriousness of trespassing varied with the distance of relationship and individuals entering the equivalent of another municipality without a good reason might well have been killed. Even today, the boats of people fishing in other's territory are confiscated. These territorial restrictions placed considerable limitations on the loci of individual movement.

4.4.5. Effective Sanctions Against Misbehavior. Chiefs and the community of Yap in the past had powerful sanctions against misbehavior. An individual's right to land could be alienated as punishment for misbehavior. This was a very serious thing, for it involved one's own name and social standing. For the young who had not yet inherited land, there was the prospect of not inheriting land or some secret knowledge from a parent.

Supernatural sanctions were also present in the past. Chiefs had an associated shamen who could apply spells and bring bad fortune. At more individual levels, there was a strong sense of need to do things right in order to be pleasing to spirits past and present.

4.4.6. Group Spirit and Individual Satisfaction. The social system of Yap provided a superstructure with specialized functions so that everyone was part of the whole. In being named, one obtained a role in Yapese society and responsibility to live one's role well. Today this interconnectedness is most strikingly demonstrated in Yapese dance, where groups of up to a hundred or more move together as if connected by the same nerve system. Each strives to be in harmony with the other dancers in the line, and also to dance their best. There is curtailment of the range of individual movement, but no curtailment of individual excellence within the pattern. The result is group excellence.

In the past, there was a rhythm to life, a division of labor, and everyone knew their relationship to each other and to their resources. No individual other than a chief could exploit more than their share of resources and no good chief would request more from his people than they could reasonably produce, as the sustainability and balance of the system had to be maintained. It was rather like a rhythmic dance between people and their resources.

5. PROBLEMS OF THE PRESENT

While Yapese culture of the past appears to have been relatively well adapted to the Yap islands ecosystem, the impact of the dense population had its effect. Today there areextensive areas of degraded soil which bear the signs of too frequent burning and too intensive use. There are few wild places on Yap and few unique forms of life compared to islands around such as

Belau, Pohnpei and even Guam. Some species such as the giant clam *Tridachna gigas* have been wiped out completely. The harsh discipline and curtailment of individual freedom were other costs of such a dense population.

Today the population of Yap State is growing very fast and consuming a great deal more. Infusions of goods, energy and technology have made it possible to forestall the consequences of trespassing the basic rules of caloric self-sufficiency and sustainability of lifestyle so that anthropocentric indicators of the islands limitations are now lacking.

Since the time that the food production, resource management and social systems described and reconstructed in this paper functioned to the fullest, there have been population reducing epidemics, World War II and the successive influence or administration of the islands by Spanish, Germans, an American Irishman, Japanese and Americans. Throughout these presences Yapese carried on their affairs as if these outsiders were just passing through. Interaction with one another remained the most important thing in life. The visitors however, had their impact. O;Keefe's big ship technology brought an end to the spirit and adventure of voyaging afar for stone money (Falanruw, 19). Population declines and World War II brought great hardships to a people whose social, energy and food production systems were so highly organized and tuned.

The U.S. Administration has been more benevolent, especially in the last 20 years or so when large sums of money have been spent on the islands. While the Administering Authority presumably had its ideas about the use of these funds for "development" , local concentration has largely been on making use of the new resources to make life easier and to carry out social obligations. The ways of getting the new resources differs and the activities of men especially, have switched from concentration on food and fiber and building to use of the new inflow of resources. The timing of the workday and fiscal year differs from that of natural phenomena and correlated social activities. The consumption of energy has increased very greatly as people commute from village to town and an electrical system is extended to the outermost villages.

Concurrent with the rise in population is an increase in the proportion of young people. With a very large percentage of the male population working at Government jobs in town, there are less opportunities for young men especially, to learn traditional technologies. Patterns of land tenure are changing and there is a lack of effective sanctions against misbehavior and declining control over people's use of resources. Life is no longer a harmonious dance between people and their resources and satisfying roles and recognition of excellence is fading. The disharmony is having its impact especially on the high proportions of youth exposed to an American TV lifestyle*6 and relatively undirected in their own heritage and its prospects for the future. The incidence of crimes and suicides has risen.

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*6 Television came to Yap about 19 largely through the efforts of Mr Robert Green, an American ex-politician who came to work in the Office of the Land Commission. His rational for bringing television to Yap was that Yapese were lazy because life was so easy and more exposure to the outside world would create wants which would make them work harder.

There has been no definitive study of the effect of television on Yap. It does seem to the author however that there has been an increase in youth problems, and violence involving innocent victims. The Yap Legislature, feeling that Yap had been tricked into getting television, has refused to commit any more funds to television, and there is little local programming. Programs are largely those provided from the U.S. While there is some bemoaning of the presumed bad impact of television, sets are widespread, and in the homes of most of Yap's leaders. One feeling, stated by Governor Mangefel, is that the sets at least keep youth at home so that they don't get into trouble in the evenings.

Scientists' recognition of the value of many traditional practices is coming at a time when there is a rush for development based on the Western development formula of applying lots of money, energy, strong chemicals, and powerful technology. The changes which are possible via the application of these resources are fast, spectacular and so attractive that they lead people to disparage their own resources, technologies and traditions of production. The unpredictability and lack of control over appropriations and programs initiated outside the State enforces an instinct to get what one can when it is available and people do not always pause to evaluate what they are losing in the process. Thus, for example, the availability of money, machines or Sea Bees dictates the bulldozing of roads during the rainy season turning carefully drained and landscaped paths into quagmires, disrupting the pattern of nutrient flow and aeration through taro patches, and eroding the soil into the lagoon where its impact on marine resources is not noticed as most of the men are in school or working in town.

6. PROSPECTS FOR THE FUTURE

Prospects for sustainable development seem dismal. Yap however, is entering the world's "development stage" at a pivotal point in human history, when goals of short term affluence are being recognized as but short term and being replaced by goals of long term sustainability and survival. There will be compelling inertia to play the development game by the old rules of exploitation. There are however, signs of growing recognition that all is not going well, and that the resource consciousness of the past is still present.

6.1 Fruit bats - A Minicase. Yap's only indigenous mammal is the fruit bat Pteropus mariannus yapensis. These large bats were eaten in the past by but a portion of Yap's population. On the nearby island of Guam however, they are a delicacy of the Chamorro cuisine, and have been hunted to the point of being declared an endangered species. About 1974, a few individuals began shipping frozen bats to Guam where they could be sold for a high price. With recognition of the money to be earned, exports increased and as the practice became commercialized traditional apportionment of the resource to but certain groups were ignored. The rate of harvest became unsustainable, populations declined, and it seemed that Yap would emulate Guam. This was noticed by Yap's leaders, many of whom still live close to natural reality, and reinforced by an ongoing U.S. Forest Service study of fruit bats (Falanruw, 1982). As a result, the First Yap State legislature placed a ban on the killing and export of fruit bats until such time as populations increase and a sustainable rate of harvest is determined. Work is ongoing to determine the best neotraditional way to manage the resource. It is notable that the legislation was passed by some of the very people earning the most from the trade, thus demonstrating their willingness to place long over short term exploitation.

6.2 Plans. There are other indicators of concern for the sustainable use of local resources. The Preamble of the Draft Constitution of the State of Yap begins: "We the people of the State of Yap: Desire to live in peace and harmony with one another, our neighbors, and our environment; Recognize our traditional heritage and villages as the foundations of our society and economy..." There are provisions in this Constitution for the recognition of traditional resource rights as well as for other conservation functions.

The draft of Yap's 5 Year Development Plan contains a provision for an Office of the Environment which would develope a comprehensive environmental management program for Yap, contribute to environmental education and do research in environmental management. There are plans for an agroforestry study which would document and evaluate many traditional land management practices, as well as their yield. There are also plans to develope opportunities for youth to learn traditional as well as modern skills.

The first steps of recognition have been taken. The next problem of course, is how to do things right. On such small islands mistakes can have far reaching environmental consequences and there is generally but one chance to do things right. There are no precedents to follow, and somehow problems have to be foreseen before they are experienced. The management of Yap's resources on a sustainable basis is a great challenge.

The Compact of Free Association being negotiated to end the Trusteeship provides for the local development of standards and procedures to protect the environment similar to a number of U.S. environmental acts such as the National Environmental Policy Act, and the Clean Water Act. How this is done is critical. If the body of U.S. legislation is merely transferred as is, it will have little more effect on conserving resources than at present (Falanruw, 1981), and will mainly provide jobs for outsiders and outside groups, and local people who learn to go through the proper motions. Then when U.S. funds are used up, the function will be dropped.

6.4 Recommendations. More lasting would be the evolution of suitable neotraditions of resource use. A version of environmentalist existed in the shamen of old Yap. Because many of the practices of the profession were enforced by no longer credible religious and social sanctions however, their function has been overlooked and the profession has about disappeared. Perhaps the time has come to develop Neoshamen, whose profession would be based on the fullest knowledge possible of Yapese culture, the laws of the natural world, and the same reverence for life inherent in the discipline and religion of their forefathers.

The work involved in the evolution of such a strategy of environmental management would involve at least the professions of ethnobiologists, traditional elders and their younger counterparts-in-training, a lawyer, and appropriate scientists and administrators. Traditional practices relating to resource use should be recorded by the ethnobiologist, elders and younger counterparts. A lawyer would compile the standards and objectives of environmental legislation required under the Compact. An ecologist, ethnobiologist and the neotraditional environmentalists would evaluate the standards and objectives and traditional practices to determine their functional aspects and what measures are needed to fill gaps for effective resource management. Finally the whole team would work together to determine where a synthesis can be made between Yapese practices and U.S. environmental legislation. The result would be a suggested body of legislation including traditional practices having conservation value and being satisfying to the human spirit; neotraditional syntheses of traditional and western practices; and other environmental regulations as needed to deal with present day problems which are not addressed by traditional or neotraditional practices.

The work would not be easy but it would be meaningful as a model for people living in the most limited of ecosystems. In many respects the issues addressed in the microcosm of Yap are those of the larger world. The difference is that on Yap they are at more of a human scale, and therefore more readily addressed. Thus Yap and other island states could provide models for the world of the future when the most modern thing will be the sustainable use of resources.

The outside world can help by educating development advisors to the limitations of island ecosystems and the need for appropriate methods, timing, and evaluation of inputs required for results, their impact, and whether these are sustainable. Opportunities are needed for practical training in applied ecology for sustainable development to assist with the development of a corps of local scientists, and support is needed for sustained efforts of en-situ scientists committed to local problems so that neotraditional strategies of sustainable resource use may continue to evolve.

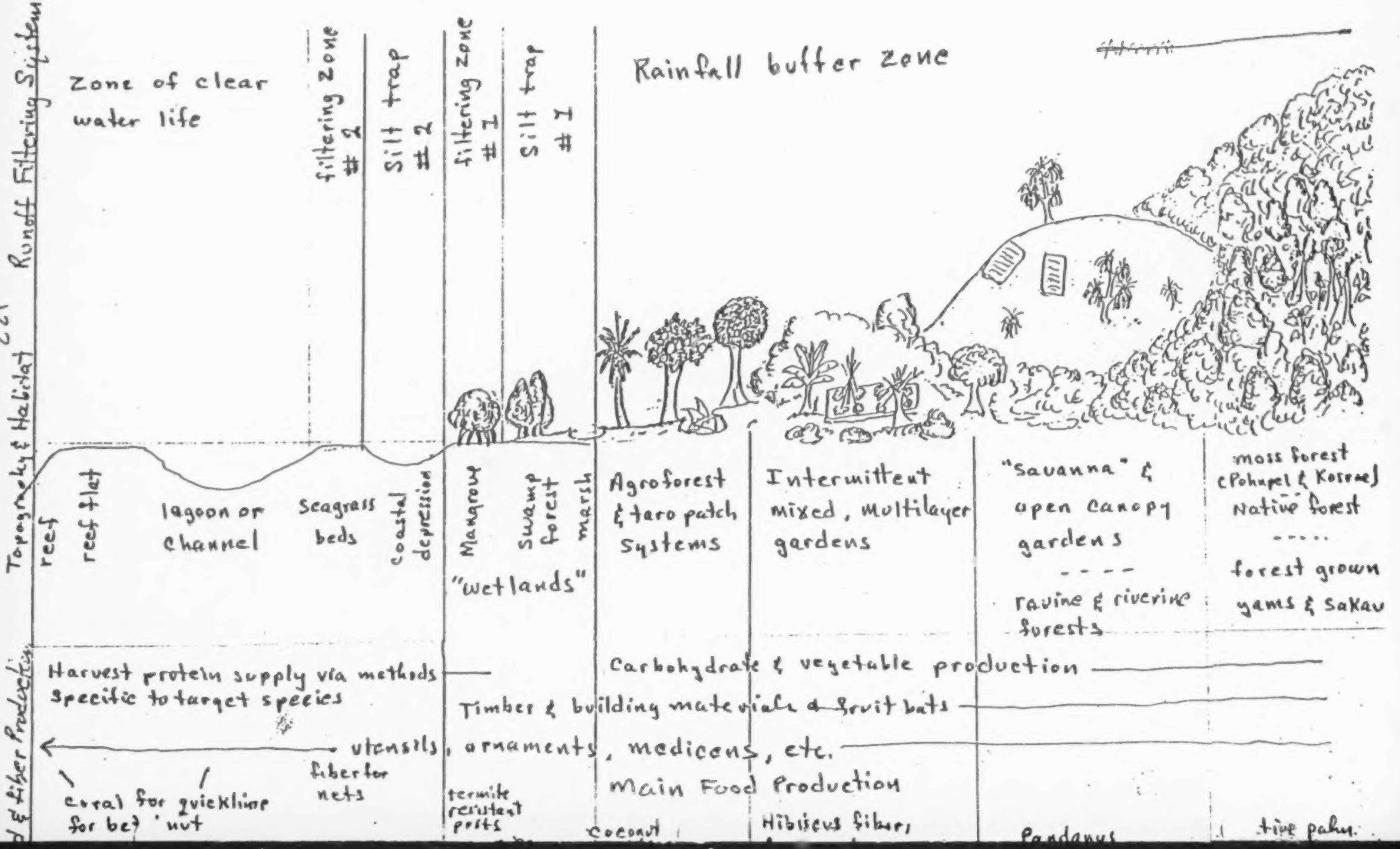
DESCRIPTION, YAP INSTITUTE OF NATURAL SCIENCE

The Yap Institute of Natural Science is a small, nonprofit organization engaged in the collection of ethnobiological knowledge and research in natural history, adaptive technology, and ecodevelopment, making applications where possible.

We are dedicated to the ideal of maintaining indigenous integrity through wise sustainable use of local resources, and the search for a valid ethno-ecological lifestyle in the Yap Islands Ecosystem.

We hope to fill gaps between pure science, the wealth of traditional knowledge and experience of the people of Yap Islands, and practical needs which may be benefitted by scientific knowledge. All too often scientific accomplishment in this area has left with its author. We have the advantage of being permanently on Yap and are therefore able to maintain a continuity of knowledge and application.

Fig. 1. Relationship between topography, babitats, and Traditional food and Fiber Production on High Islands of The Carolines


Runoff Filtering System:
Zone of clear water life
filtering Zone # 2
Silt trap # 2
filtering Zone # 1
Silt trap # 1
Rainfall buffer zone
Topography & Habitat
reef
reef flat
lagoon or channel
Seagrass beds
coastal depression
Mangrove
Swamp forest
marsh
"wetlands"
Agroforest & taro patch Systems
Intermittent mixed, multilayer gardens
"Savanna" & open canopy gardens
- - - -
ravine & riverine forests
moss forest (Pohnpei & Kosrae)
Native forest
- - - - -
forest grown yams & sakau
d & fiber Production
Harvest protein supply via methods specific to target species
Carbohydrate & vegetable production
Timber & building materials & fruit bats
utensils, ornaments, medicens, etc.
Main Food Production
fiber for nets
coral for quicklime for bet 'nut
termite resistant posts
Coconut
Hibiscus fiber,
Pandanus
tive palm

Caroline Island "Specialties"

Belau extensive. rich & beautiful marine areas	extensive & most species rich mangrove and riverine swamp forest	limited agroforest extensive habitat & well developed local technology for taro (Colocasia) production	limited	extensive savanna open canopy production of Cassava	~~rich~~ native forest rich in species & endemics
Yap limited to moderate nearshore marine resources		VERY well developed taro patch & agroforest systems the latter species rich	well developed gardening systems	extensive savanna some open canopy sweet potato production	limited, native forest
Truk extensive but damaged marine areas		extensive but species poor agroforests		limited	limited remnant native forest (except for Tol) with high rate of endimism
Pohnpei moderate to good marine Res.	extensive mangrove, some swamp forest	fairly extensive agroforest		limited	traditional yam & sakau prod.
Kosrae limited to moderate marine areas	mangrove mostly inside coastal fringe, very well developed	moderate to agroforests, esp. citrus			Well developed Native forest & unique moss forest

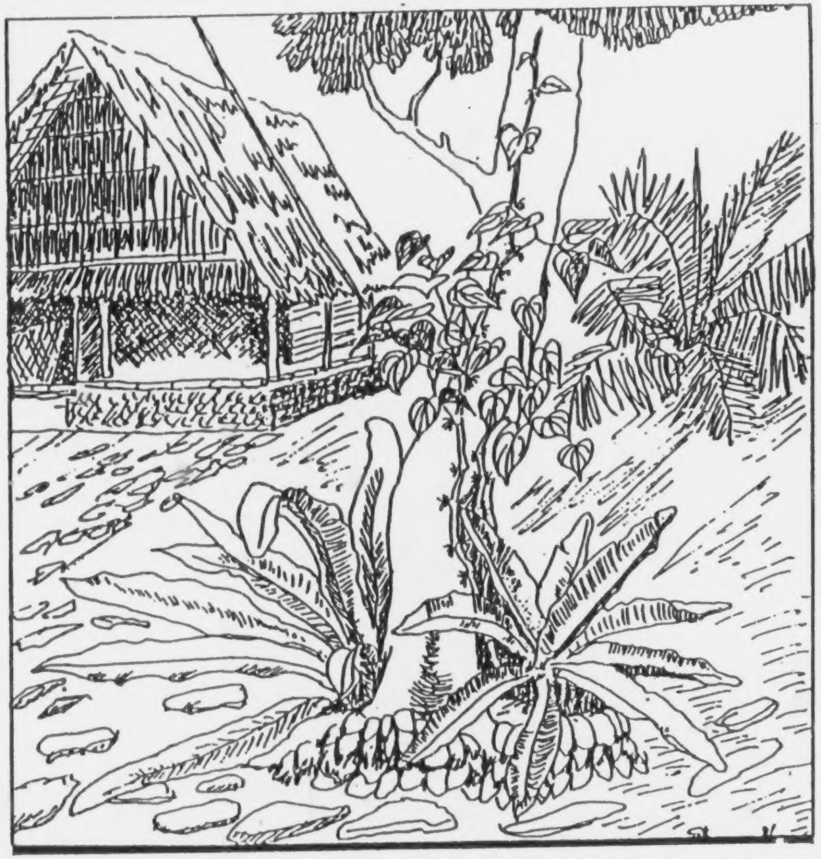
Figure 4.

A YAPESE GROWING SYSTEM

Though much less celebrated than its voyages for stone money, a notable achievement of Yap is the development of a relatively self-sustaining system of agriculture that orchestrates tree gardens, taro patches and root crops with fallow phases, into a system that produces food year round with a minimum input of energy. The main characteristic of this system is that it is "nature intensive". Rather than rearranging the environment and expending great amounts of energy and chemicals, people's activities are directed to the most effective use of microhabitat and natural phenomena.

Someday "nature intensive food production systems will be as recognized and respected as Asian "labor intensive" and Western energy and chemical intensive methods.

For a nature intensive system to work however, people must be very aware of natural phenomena. Today on Yap there are many distractions such as television to take people's concentration away from natural phenomena and food producing activities.There seems to be a race to see whether Yap will discover the value of some of its own practices before the knowledge and instincts required for those practices dies.

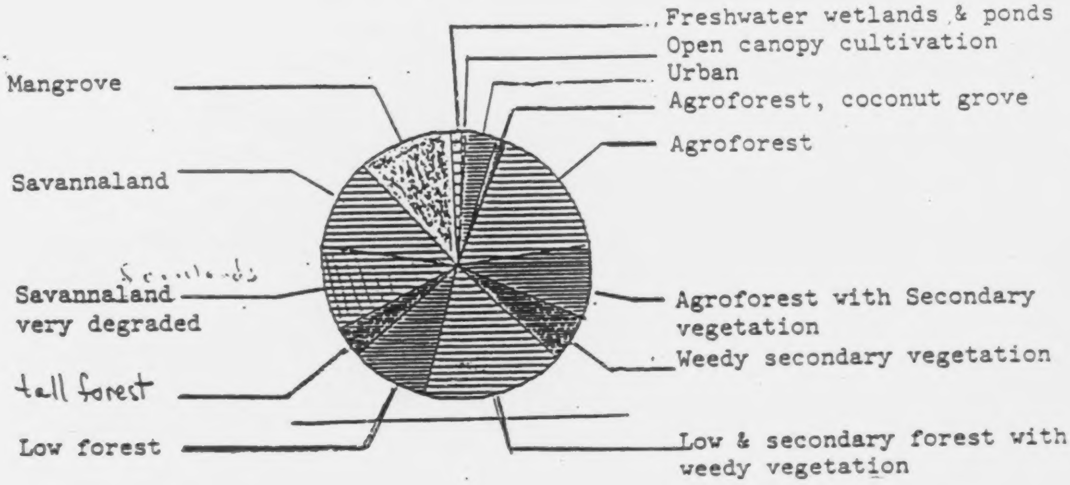


Drawing by Stanley Kenrad : Gabuey in its natural village setting with coconut husk mulch and bird's nest fern to gather humus and moisture.

Gabuey, known to scientists as Piper betle,is an important plant on Yap as it releases alkaloids when chewed with betle nut and lime. The gabuey vine requires a fairly constant supply of moisture to live and Yapese have an ingenious way of growing it so that it makes it through the dry season. It is planted at the base of a tree or other support, coconut husks are piled around, and chath the bird's nest fern, Asplenium nidus, is planted. The fern is an epiphyte and does not compete with the gabuey for soil nutrients. Its leaves though, act like a living funnel to collect moisture and humus to provide a moist environment for the roots of the gabuey, helping it through even severe droughts.Gabuey is also used medcicinally and the chath, besides looking nice, can be used both as medicine and as food. Then when the gabuey leaves are picked,they may be wrapped in chath leaves to keep them fresh! The system is a lovely combination of beauty and function characteristic of Yapese ethnobotanical sophistication.

Source: Yap Institute of Natural Science - 1984. Yap Almanac Calenc

Figure 2: Main Categories of Vegetation on Yap



Source: Draft map of vegetation of Yap, (Falanruw et al in-prep. U.S. Forest Service.)

Figure 4.3.

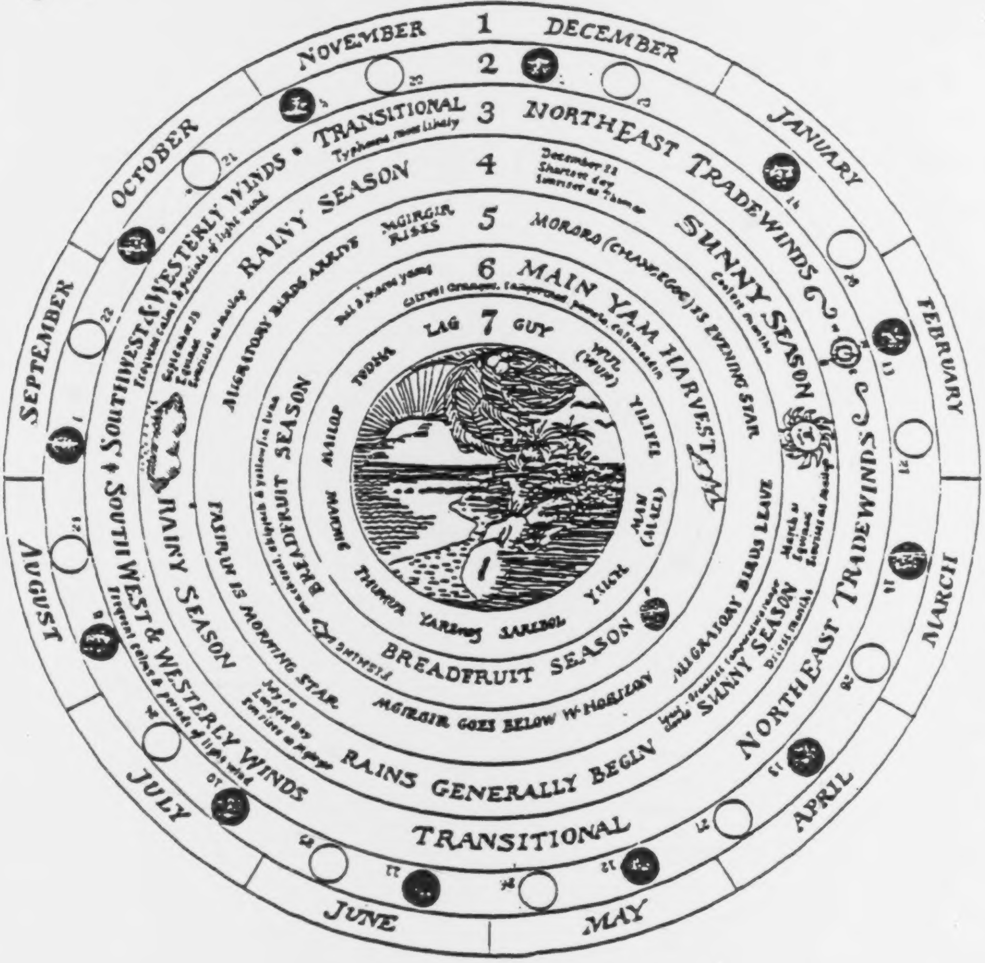

1
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
2
3
TRANSITIONAL
Typhoons most likely
NORTHEAST TRADEWINDS
SOUTHWEST & WESTERLY WINDS
Frequent calms & periods of light wind
NORTHEAST TRADEWINDS
TRANSITIONAL
SOUTHWEST & WESTERLY WINDS
Frequent calms & periods of light wind
4
RAINY SEASON
December 22
Shortest day
Sunrise at Tamor
SUNNY SEASON
Coolest months
SUNNY SEASON
Driest months
RAINS GENERALLY BEGIN
RAINY SEASON
5
MGIRGIR RISES
MORORO (CHANGEGOG) IS EVENING STAR
MIGRATORY BIRDS LEAVE
MGIRGIR GOES BELOW W. HORIZON
FASIRUN IS MORNING STAR
MIGRATORY BIRDS ARRIVE
6
MAIN YAM HARVEST
BREADFRUIT SEASON
BREADFRUIT SEASON
7
LAG
GUY
WUL (WUN)
YILIYEL
MAN (MAL)
YIICH
SARIDOL
YARENG
THUMUR
MACHIG
MAILOP
TODHA

Figure 1

market records Jan 1978-Oct. 1979:

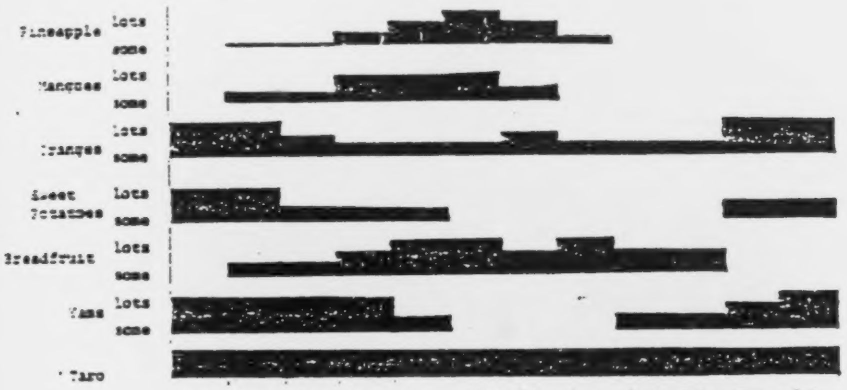


Figure 3

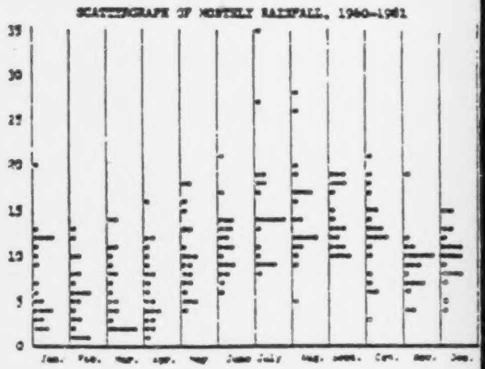


Figure 2

(Figures 1-3 taken from the Yap Calendar and Almanac, 1981 & 1983, published by the Yap Institute of Natural Science)

Background Paper No. 2

COMMERCIAL CROP PRODUCTION TECHNOLOGIES AND DEVELOPMENT POTENTIALS FOR THE U.S.-AFFILIATED PACIFIC ISLANDS

by

William Raynor
Ponape Agriculture and Trade School

1986

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ABSTRACT

Under the U.S. Administration commercial agricultural development has stagnated, due to an emphasis on social and physical infrastructure development, and direct financial assistance to local governments. Still, commercial agricultural development is much desired in all the islands.

The major cropping technology introduced up to now has been monoculture. Polyculture systems are more desirable given the resources on most islands, and these technologies, especially agroforestry, which is the basis of traditional agricultural systems, should be further developed. Small-scale mechanization, mainly rototillers, sprayers, grasscutters, etc., are appropriate for small-scale commercial cropping. Irrigation is needed on the dryer islands, especially Guam, CNMI, and Yap, and drip irrigation holds the greatest possibilities. Greenhouses, shadehouses, and hydroponics are currently being used in some areas, and have some potential for production of high-value crops and for atolls and urban food production. Agricultural pests and low soil fertility are major constraints, but imported pesticides and fertilizers are expensive and often unavailable. Appropriate technologies, such as Integrated Pest Management (IPM) and local fertilizers are being introduced and use of these should be expanded. Salt is also a problem in some areas, and appropriate technologies have been developed to minimize salt damage to crops.

Food crops are important to local food supply and for import substitution and local nutrition, but markets are limited. Spice and specialty crops are being developed in some areas and show some potential for development when quality control is practiced and marketing aimed for the gourmet market. The main oil crop is and will continue to be copra, although essential oil crops, if properly developed, have some potential. Tropical fruit crops could become increasingly important if marketing, quality control, and processing are improved.

Markets need to be expanded, both local and export, and coordinated market development for the region would minimize competition. Cooperatives, if properly developed can be valuable in commercial agricultural development. Research and extension are key areas for commercial agriculture, and the federal Land Grant program has made some improvements. Cooperation with other developing areas and international agencies should be increased, especially within the South Pacific region.

The U.S. government must make a real committment to commercial agriculture development by extending more farmer support programs to the area, tailoring USDA food help programs to support more local food purchases, increasing direct assistance for agricultural infrastructure development, increasing assistance in research, development, and extension programs, and assisting in market development. Local governments should practice market intervention to increase competitiveness of local products with imports, clarify land titles and surveys, institute land taxes, improve planning, expand vocational agriculture education, and increase cooperation with other U.S.-affiliated Pacific islands and foreign governments in the area.

"Commercial Crop Production Technologies and Development Potentials for the U.S.-Affiliated Pacific Islands"

Introduction:

The potential for commercial agricultural development in the U.S.-affiliated Pacific Islands has long been recognized by planners and other officials. In Micronesia, numerous attempts have been made, beginning with the Germans in the late 19th century, who developed a sizable copra trade. The Japanese expanded commercial agriculture through the cultivation of sugarcane in the Northern Marianas, cassava, sweet potato, coffee, etc. in Pohnpei, and various other commercial farming and related industries throughout Micronesia (Nishi, 1968). Both the German and Japanese efforts, though were mainly set up for the benefit of the colonial power itself, and natives were used mainly as unskilled labor. With the advent of the U.S. administration at the end of WW II, the Japanese-supported commercial agriculture development, which led to Micronesia becoming a self-supporting, viable part of the Japanese Empire, quickly disappeared. Initially, exploitation of existing island resources was a very low priority with the new U.S. administration, military possibilities and exclusion of the area to outside powers, being much more important, and without expatriate managers, shipping services, and markets, commercial agriculture was soon abandoned and the islands again returned to subsistence food production. Agricultural development in American

Samoa, which became a U.S. possession in 1900, has been even more neglected than in Micronesia, and although a small copra industry was developed, most agriculture activity is still at a subsistence level.

Within the last 30 years, there have been renewed efforts by territorial governments to develop commercial agriculture, but progress has been agonizingly slow and results disappointing. Several crops were targeted for commercial development in Micronesia, notably cacao in the late 50's and early 60's, ramie in Palau, coconut throughout the islands, rice on Pohnpei, banana on some high islands, and more recently black pepper on Pohnpei and vegetables throughout Micronesia. (Migvar, 1965a & b, Ogata, 1966, Sprout and Migvar, 1964, and Hadley, p.c., 1985). All have been introduced as small-scale projects for limited-resource farmers, and all for the most part have been unsuccessful for various reasons, among them lack of markets, low prices, technologies dependent on imported inputs, lack of management skills among farmers, diseases and pests, and a general lack of commitment by U.S. and local governments. Efforts in American Samoa have been mainly in increasing local food production with some effort made to introduce commercial vegetable production.

Commercial agriculture development has continued to be emphasized in development plans as desirable for the U.S.-affiliated Pacific Islands, mainly to increase employment opportunities in the rural and out-lying areas to stem migration to already over-crowded district centers, to build the private sector through exploitation of local resources, to increase local food production, to replace imported food items and build self-dependence, and to generate cash for the island economies. As in other developing Pacific nations, it is also recognized that agriculture development is one of the best approaches to development in an area that desires economic development in a manner consistent with their cultural heritage and social environment (Mark, 1982a).

With population rapidly increasing, imports increasing, local production stagnated, and no projected growth in government sector employment, planners are putting increased emphasis on local resource development, especially in the areas of agriculture and fisheries. Unfortunately, most efforts have thus far met with failure. In most of the U.S.-affiliated islands, agriculture is still at a subsistence level, with little production reaching the local market, and even less being exported. Copra remains the major agricultural export crop, and increasingly large amounts of rice, flour, and canned goods are being imported to fill the gap between local production and consumer needs (Polson, 1983).

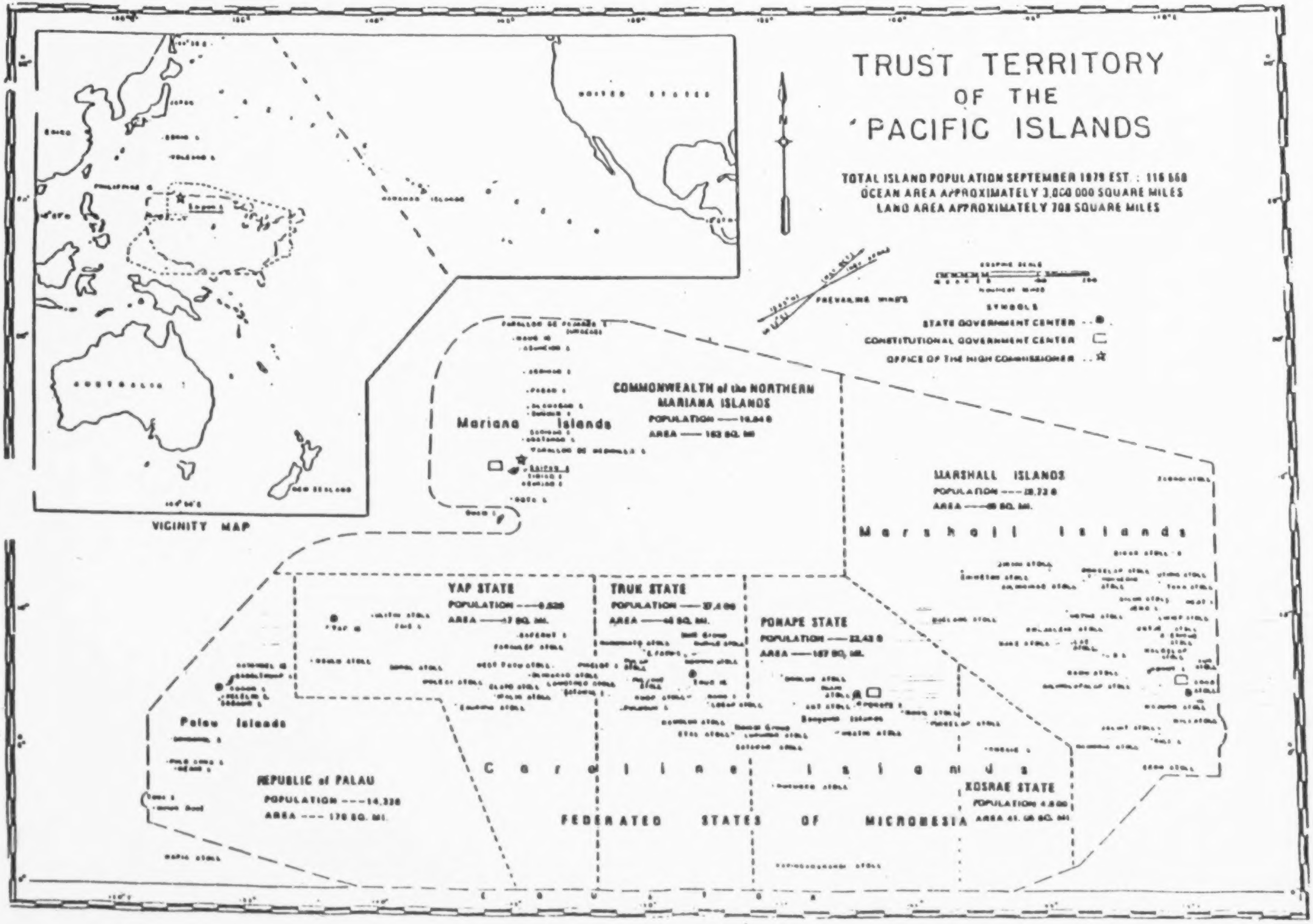
Commercial crop technologies need to be developed, and appropriate government actions taken to improve the climate for commercial agriculture growth. This paper attempts to detail some of the major agricultural technologies and crops that are or could be used in the region, as well as presenting some suggestions for improving commercial agriculture development in the U.S.-affiliated Pacific Islands.

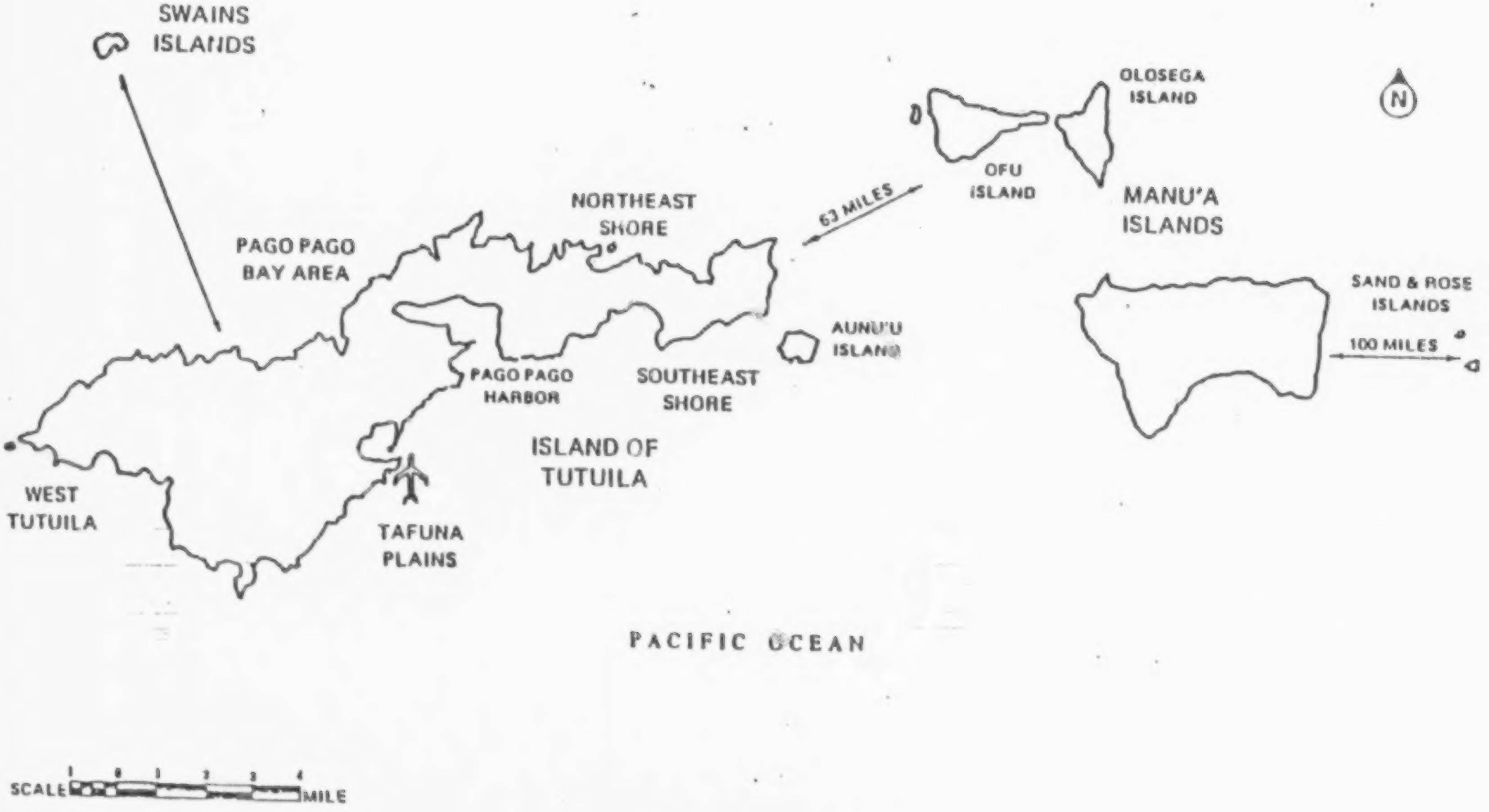
DEMOGRAPHIC DATA FOR U.S.-AFFILIATED PACIFIC ISLANDS (1980)

Government Entity	Size (mi2)	Population	Ave. Rainfall (inches)	Ave. Temp. (o)
Federated States of Micronesia:				
Pohnpei	133.36	22,367	193	80.6
Kolonia	-	5,550	-	-
Truk	49.18	37,383	138	80.6
Moen	-	10,374	-	-
Yap	45.93	8,172	122	81.2
Colonia	-	5,227	-	-
Kosrae	42.3	5.522	218	80.6
Lelu	-	1,998	-	-
Republic of Belau	190.66	12,173	144 (Koror)	81.0
Koror	3.62	7,685	-	-
Republic of the Marshall Islands	69.84	31,045		
Majuro	3.54	11,893	143	81.0
Ebeye	0.12	6,629	101	81.0
Commonwealth of the Northern Marianas				
Saipan	47.0	14,549	75	na
Tinian	33.0	866	72	na
Rota	39.0	1,261	121	na
Territory of Guam	212.04	105,979	-	82.0
Agana	1.16	896	91	-
American Samoa	77.4	32,395	128	80.0
Tutuila	53.0	30,212	-	-

na- Data not available

Source: Pacific Daily News and other miscellaneous materials.

TRUST TERRITORY
OF THE
PACIFIC ISLANDS
TOTAL ISLAND POPULATION SEPTEMBER 1979 EST. : 116 560
OCEAN AREA APPROXIMATELY 3,000 000 SQUARE MILES
LAND AREA APPROXIMATELY 708 SQUARE MILES
N
PREVAILING WINDS
GRAPHIC SCALE
NAUTICAL MILES
SYMBOLS
STATE GOVERNMENT CENTER ●
CONSTITUTIONAL GOVERNMENT CENTER ☐
OFFICE OF THE HIGH COMMISSIONER ☆
UNITED STATES
AUSTRALIA
NEW ZEALAND
PHILIPPINES
MARIANAS ISLANDS
VICINITY MAP
COMMONWEALTH of the NORTHERN MARIANA ISLANDS
POPULATION ——16,840
AREA —— 183 SQ. MI.
Mariana Islands
SAIPAN
MARSHALL ISLANDS
POPULATION ——29,730
AREA ——70 SQ. MI.
Marshall Islands
YAP STATE
POPULATION ——8,520
AREA ——47 SQ. MI.
TRUK STATE
POPULATION ——37,400
AREA ——46 SQ. MI.
PONAPE STATE
POPULATION ——22,430
AREA ——187 SQ. MI.
KOSRAE STATE
POPULATION 4,800
AREA 41. 46 SQ. MI.
Caroline Islands
FEDERATED STATES OF MICRONESIA
Palau Islands
REPUBLIC of PALAU
POPULATION ———14,330
AREA ——— 178 SQ. MI.
EQUATOR


SWAINS ISLANDS
PAGO PAGO BAY AREA
NORTHEAST SHORE
63 MILES
OFU ISLAND
OLOSEGA ISLAND
MANU'A ISLANDS
SAND & ROSE ISLANDS
100 MILES
N
AUNU'U ISLAND
PAGO PAGO HARBOR
SOUTHEAST SHORE
ISLAND OF TUTUILA
WEST TUTUILA
TAFUNA PLAINS
PACIFIC OCEAN
SCALE
1
0
1
2
3
4
MILE

AMERICAN SAMOA

1. MAJOR TECHNOLOGIES:

Monoculture:

Monoculture, *the growing of a single crop on the same land at a given time*, has been the main commercial cropping technology introduced to the islands up to this time. Historically, colonial powers have favored the monoculture approach- the Germans with coconut plantations, the Japanese with sugar cane, rice, cassava, sweet potato, etc., and the Americans with cacao, rice, banana, ramie, black pepper, etc. Traditionally, though, there are very few cases of monoculture in local agriculture, with the notable exceptions of taro patches, and perhaps rice and corn (introduced by the Spanish) on Guam.

Benefits of monoculture are many, and thus large agricultural systems have been built around this technology. In the U.S.- corn, soybeans, cotton, rice, citrus, and wheat are just a few of the crops grown in monoculture. The main advantage of monoculture is uniformity: in planting, fertilizing, cultivating, and harvest, thus favoring intensive inputs- improved and hybrid varieties, fertilizer, chemical pesticides, and mechanization, giving high yields per unit of land.

This very advantage, though, often becomes a disadvantage when monoculture technologies are incorporated into small-scale farms with limited resources. Capital is often not available to invest in the improved inputs needed for successful monoculture, and labor, which tends to be concentrated into peak periods such as tillage, planting, and harvesting, is rarely available to a farmer who must depend mainly on his family. The uniform harvest and greater yield requires storage, processing and marketing facilities. These are not currently available on many of the U.S.-affiliated islands (Mark, 1982a). Monoculture also encourages pests and diseases to proliferate in the absence of natural barriers found in balanced ecosystems. Also, in monoculture, as in any cropping system that needs total land-clearing and regular tillage, erosion can be a serious problem, even when terraces and contour-farming are practiced.

All of these factors add up to a generally risky prospect, and one that few small-scale limited-resource farmers, who depend on their farm for their family's food, are willing to undertake. Another factor, which planners and agriculturalists tend to overlook, is that a small farmer, faced with decisions on how best to use his extremely limited land resource, is very likely to shy away from any technology that will entail his tying up a large percentage of his land to grow a single crop, especially if his main goals are to feed his family and meet his cultural obligations (Harwood, 1985).

Monoculture does, however, hold some possibilities for further development in Micronesia, especially in those areas where land holdings are relatively large (ie.- on government leased lands). Ponape Agriculture and Trade School on Ponape has been running a 20 acre mechanized commercial farm, with some success, for nearly 10 years based on monoculture of sweet potato, corn, cassava, banana, and beans.[1] Farmers in Guam and the Northern Marianas have also developed successful vegetable monoculture systems.[2] Each of these systems depend on a number of factors- mainly excellent tillage and cultivation, generally by machine, well-planned crop rotation schemes, and imported commercial fertilizer and pesticides. Also, markets in these areas are fairly well-developed, with the exception of PATS, where most of the farm produce is consumed by the students.

Among the new methods of monoculture that have been developed in Africa, the U.S., and other parts of the world are no-tillage, minimum tillage, conservation farming, and mulch tillage. These systems are similar in that they all replace tillage with herbicides, mainly Paraquat and Glyphosphate (Round-up), for the purpose of cutting down on erosion and/or lowering capital investment in large tillage machinery. Conservation farming has been highly developed at the International Institute of Tropical Agriculture (IITA) in Nigeria, and the concept is quickly spreading throughout the tropics. Proponents of the system claim that the dead mulch left after herbicide kill cools the soil, surpresses weed growth, encourages water retention and the growth of soil building organisms, as well as cutting down erosion up to 98% (Wijewardene and Waidyanatha, 1984). Simple, low cost tools such as ULV (ultra low volume) and CDA (controlled droplet applicator) sprayers and injection planters have been developed and are now commercially available in England and the U.S.

With the high cost of herbicides imported into Micronesia,[3] the danger of pesticide misuse, and the general reluctance of farmers to practice monoculture technologies, it is doubtful if any of these systems will have any immediate benefit to commercial agriculture development in Micronesia. There may also be a danger, although not yet recognized, of herbicides having a negative effect on ground water and marine environments. They should however be experimented with in certain areas where commercial monoculture is already being practiced, especially for production of grain crops such as corn.

Polyculture:

Polyculture is a new/old system, adapted mainly from the traditional farming systems of South-east Asia. Generally polyculture, or multiple cropping, consists of *mixing together two or more different crops on the same land unit either concurrently or sequentially.* The most common is known as intercropping, or the planting of two or more crops together at the same time in various layouts- by row, strip, or in a random mixture. Intercropping is often practiced between slow-growing perennial crops to utilize sunlight and space between the crop before it's canopy closes. This practice is common in rubber in S.E. Asia and with various other perennial crops throughout the Pacific (Gomez and Gomez, 1983).

Another system is relay cropping, which consists of a second crop being planted into the original crop after flowering but before harvest. This gives a second crop without tillage on a piece of land, and has been developed by the IRRI in the Phillipines as a strategy to increase the overall production of rice farmers in Asia (Gomez and Gomez, 1983).

Agro-forestry, the mixture of annual and perennial crop and forestry species, sometimes with animals, is a system of polyculture that is common to traditional agricultural practices in the Pacific (Polson, 1983). Permaculture, basically an agro-forestry system with a "self-sufficiency through nature" philosophy, is another agro-forestry system developed in temperate Tasmania in recent years (Mollison and Holmgren, 1981). Basically, both of these systems depend on the creation and maintenance of a multi-storied, semi-permanent and stable system, that at it's climax condition, requires little labor or other inputs, such as fertilizer or pesticides. The productivity of the system is based on the interactions between the plants and animals themselves, the result being the creation of a stable, productive ecosystem resembling a native "jungle" of annual and perennial crops and animals, thus giving the farmer a continuous food and product supply over a long run. Because of slope and low soil fertility, agro-forestry will continue to be a major production technology in the future for most of the U.S.-affiliated Pacific islands.

Another recent development in polyculture has been alley or avenue cropping, also developed at IITA in Nigeria (IITA Annual Reports, 1980-84). Basically, the system consists of planting trees, usually a fast-growing, nitrogen fixing legume species (most commonly Leucaena or Gliricidia), in rows, with the alleys or avenues in between being cropped with various annual crops. The deep-rooted trees, acting as nutrient pumps and erosion barriers, are pruned constantly, and the prunings are laid in the rows and plowed in as green manure fertilizer. The system has been further refined by Harold Watson in Mindinao, Phillipines, with his SALT (Sloping Agricultural Lands Technology) system, which consists of double row hedges of Leucaena, spaced 4 meters apart on contour, cut back 10 times/year, with prunings being used to fertilizer crops planted between the hedges without plowing (NFTA News, Oct. 1985).

Other integrated systems are the Integrated Farming System (IFS) developed by George Chan, the former Energy Planner for the Commonwealth of the Northern Marianas (Marianas Variety, June 1983), and it's new off-shoot, Biogenic Farming, being proposed for some projects in Guam (Barcinas, p.c., 1985). Basically these systems revolve around a bio-gas digestor and and an animal unit, integrated in with algae and fish ponds, with annual and tree crop production using the effluent as fertilizer and irrigation. The cycle thus realized between plants and animals is extremely energy efficient. While the theory of the system has been praised, the practical applications have been so far largely unsuccessful, except in experimental situations.[4]

There is an increasing awareness that polyculture systems are superior to monoculture systems in that they are more ecologically stable (Vergara, 1982, Sommmers, 1982, 1983). The mixture of crops and, in some cases, animals, discourages pest and disease infestations, and the increased, multi-story canopy decreases erosion, increases capture of sun energy for increased photosynthesis, and shades and cools the soil, while the varied root systems use the soil profile and nutrients more fully. Generally overall production is higher than in monoculture systems. The increased stability and variety of crops and livestock are added benefits, as is the symbiotic interaction between different species, resulting in a much more self-sufficient and sustainable system.

Polyculture has not been developed for large-scale commercial agriculture mainly because it does not lend itself well to mechanization or increased fertilizer and pesticide inputs. Polyculture systems also take more planning and management than monoculture if they are to become fully productive, since several different crops must be cared for on the same land unit.

Polyculture is already practiced throughout the islands, especially in the traditional subsistence agriculture. Intercropping and interplanting holds great promise for increasing overall production on land between coconuts, banana, black pepper, etc., especially in young plantings. Interplanting of legumes can also add nitrogen to the soil through the action of Rhizobium bacteria, and can improve yields, as well as suppressing undesirable weeds, cooling the soil, minimizing soil erosion, and conserving soil moisture (Lal, 1978).

Vegetable production lends itself extremely well to polyculture, and much production outside of Guam and the CNMI is based on this mixed gardening concept. UNICEF is currently promoting a system of mixed gardening for nutrition throughout Micronesia, based on traditional Phillipine homestead farming, on which the author is serving as an advisor.

Polyculture, especially agro-forestry-based systems, hold great potential for commercial agriculture development, as well as increased local food production for self-sufficiency. New and higher-yielding varieties and improved spacing and arrangement can be introduced to traditional systems. It is much easier to introduce improvements to existing systems than to replace them (Harwood, 1979). Planners must realize the continuing importance of traditional subsistence agriculture to the continued well-being of the population and the great, but often unrecognized, contribution that traditional agriculture makes in terms of food production and employment of human and other local resources.

Mechanized and Irrigated Crop Production:

Mechanization and irrigation, along with use of fertilizer and pesticides, are considered integral components to modern commercial agriculture. Increased mechanization gives the farmer the ability to farm larger amounts of land with less labor, and proper irrigation gives increases in yield and more control of production to the farmer, and many times determines the survival of the crop. Both are capital intensive, though, and thus are not easily adopted by the small-scale, limited resource farmer of Micronesia.

Primary tillage, *the loosening of the soil surface to disrupt weed growth, burying the debris to some degree in the process* (Harwood, 1979), is the first priority for mechanization. Tillage by hand is extremely labor-intensive, and is made more difficult in the heat of the tropics. In the author's experience, except for the construction of taro patches and limited tillage by farmers on Palau, Guam, and the CNMI, large-scale primary tillage is not common in the U.S.- affiliated Pacific Islands. There is, however, every indication that increased availability of tillage equipment, from rototillers to tractors, whether by sale, rent, or custom-hire, would stimulate increased farming activity, as Pohnpei State DOA has found out with their popular equipment services program (Lorens, p.c.,1985).

The question with mechanization, then, is not whether it is needed, but what scale is desirable. Already, anything from 2 1/2 HSP rototillers to 80 HSP 4 WD tractors can be found in U.S.-affiliated islands[5]. Currently the highest degree of farm mechanization is on Guam, with several farmers actually owning their own tractors and equipment.

Animal power, considered to be a logical development step between hand and mechanical tillage, has for the most part been bypassed in the U.S. Pacific except in Guam, where caribao tillage was probably introduced by the Spanish administration. Small herds of caribao are also found on a few of the other Micronesian islands, where they are used mainly for transport, using sled-type implements. These were probably brought in by the Japanese, who used caribao for various purposes, including logging. In the 1960's, a project to breed and train caribao was initiated in Palau by the T.T.P.I. government, and caribao were billed as the only sensible farm power for hilly, shallow soils of Micronesia, and the capital poor Micronesian farmers (Sprout and Migvar, 1964). Farmers, though, did not adapt animal power, and even today, many commercial farmers on Palau still use the "ossib" or the three-pronged hoe that the Japanese made popular during the 1920's and 30's.[6]

Another small-scale machine introduction was the Merry-tiller on Pohnpei, a 2 1/2 to 3 HSP rototiller designed for small gardens. Jim Hiyane, then District Agriculturalist for Ponape District, used revolving fund money to make the tillers available for farmers to purchase. Several farmers purchased the tillers, which later were found to be too weak to do primary tillage.

At this time, very few farmers in the F.S.M., Palau, Marshalls, CNMI, or American Samoa own farm machinery. In some areas, the State Agriculture Divisions do tillage for the farmers, especially those nearest the district centers, for a nominal fee, using government equipment (Mark, 1982a, Lorens, Ansin, and Falanruw, p.c.s, 1985.) In other areas, such as in American Samoa, Guam, and Saipan, rototillers and some other small equipment are loaned out to farmers. Pohnpei State has an ambitious equipment services program, including 2 bulldozers and 6 Yanmar tractors with attachments, which do farm clearing and bed preparation for farmers at subsidized rates of $10 and $6/hr., respectively. This program was responsible for an estimated 152 farms cleared and 10 miles of farm roads completed in 1984 alone.[7] The major problem is the great farmer demand for the machinery, which results in farmers having to wait as long as 6 monthes to a year before they can get machine service (Lorens, p.c., 1985).

From experience at PATS High School and other institutions throughout the region, it seems that this type of program is good for initial clearing and tillage, but further mechanization needs to be considered. Few farmers would seriously consider animal power, but rototillers in the range of from 8-12 HSF, which are available from Japan, U.S., and Australia, can and are being used. A 12 HSP rototiller technically should be able to handle up to 5 acres of crops per year (Harwood, 1979), more than sufficient for the average farmer in the area. Capital investment in this type of tillage machinery is not prohibitive to individual farmers (about $2-3000), and could even be purchased cooperatively.

In Guam, the trend is definitely towards increased mechanization, and with relatively high wage rates, and a general reluctance towards hard physical labor, this will probably be the case throughout Micronesia. Guam has large areas of flat, well-drained, cleared and accessible land, as do Saipan, Tinian, and Rota, which can support large-scale mechanization. In the rest of islands, only Pohnpei and Palau, and to some extent American Samoa, have any suitable areas. In the two Micronesian entities, these are for the most part government lands. For most farmers, it is doubtful whether anything larger than a rototiller would be suitable, in terms of capital investment, timeliness, or capacity.

Consideration must be taken in machinery selection, especially in ease of service and repair and availability of spare parts. The local governments will probably have to be involved in initial machinery trials and farmer training, as well as development of skilled maintenance and repair personnel.

Secondary mechanization- seeders, sprayers, harvesting equipment, processing equipment, chainsaws, grass-cutters, pumps for irrigation, etc.- all need to be considered as agriculture becomes more advanced. Sprayers are available at many ag. stations throughout Micronesia and many other farm machineries are used at government agriculture facilities that is or could be made available to farmers. In Guam, many farmers are now investing in secondary mechanization (Barcinas, p. c., 1985) One Guam pineapple farmer will be purchasing juicing machinery shortly to process his over-production into a storable product (Barcinas, p.c., 1985). Private business should eventually be encouraged to import and sell farm machinery, but the local government must do the initial evaluation and selection of suitable machineries. Cooperative ownership, as with the black pepper processing machinery on Pohnpei and refrigeration and marketing facilities on some islands, should also be encouraged.

Irrigation:

Irrigation is a definite need on many of the islands, especially for commercial production, as many islands, especially Guam, Yap, and the CNMI, experience a dry season of varying lengthes. Only Pohnpei and Kosrae have enough rainfall to crop year-round without supplementary water. In traditional agriculture, planting usually coincides with the rainy season, while harvest coincides with the dry period. To the author's knowledge, only Guam and the Northern Marianas have developed any notable irrigation technologies.

The major irrigation technologies are flood, furrow, sprinkler, and drip irrigation. Flood irrigation is generally practiced in level areas. It is well-suited to rice and taro production. It requires a system of dikes to control water flow and penetration. This type of irrigation was practiced by the Japanese in some areas and also with rice in Pohnpei during the 1960's. Of all the systems, flood irrigation requires the greatest amount of water, and if land is not leveled, it is largely ineffective. It does have some applications, especially for rice or taro production on bottom lands, where a good source of water can be diverted by gravity into the field.

Furrow irrigation involves planting on raised beds and irrigating in furrows on each side of the beds. Generally very porous soils, or heavy clays, do not respond well to this system. It also requires leveled land and large amounts of water. The major benefit, as with flood irrigation, is that where water is plentiful and land is level, it does not require a large amount of capital. Furrow irrigation hold some potential for the U.S.-affiliated islands, especially in the CNMI, where large level areas of land are found and sufficient water storage can be developed.

Sprinkler irrigation is more suited to sloping and hilly lands. The system is also suited to annual, perennial, or even to polyculture and agroforestry systems. The technology consists of a water source, a pumping system, and movable pipes with sprinklers. The pipes and sprinklers are continually moved around the field, to give the crop an even amount of water. Sprinkler irrigation requires fairly large amounts of water, and it is capital intensive in terms of pumps, pipes, and sprinklers, and the labor required to set them up and move them. Management also is very important to ensure adequate irrigation throughout the field, and to keep the system functioning. The author has observed sprinkler irrigation being used to some extent in Guam and the CNMI, especially where water is available through government irrigation projects.

Drip irrigation is the latest in irrigation technology, much of the technology coming from Israel's attempt to "farm the desert." Drip or trickle irrigation is the most versatile system in that it can be applied to all kinds of crops or crop mixtures, on sloping or flat lands, and even in greenhouses. It is appropriate to small or large-scale farms. The system consists of a water source under some pressure (gravity can be sufficient in some cases) fed into a series of hoses or pipes that have small openings or drip nozzles feeding near the base of the crop plants. As the name implies, water is dripped in these localized areas. Drip irrigation is superior to the other systems in that it uses much smaller amounts of water, and it waters only the plants, thus cutting down on weed infestations between crop plants. Fertilizer and other nutrients can easily be fed into the system. Labor is less because once the tubing is laid, it stays in place until the crop is mature. In Hawaii, the author observed drip hose developed for sugarcane irrigation that is biodegradable, and it can be left in the field after crop maturity and plowed in. Drip irrigation systems are fairly capital intensive, though, and management is very important as water flow must be continually monitored to assure it's effectiveness.

In Guam and the CNMI, irrigation is an important part of dry-season crop production. There are 72 irrigated acres of government land on Tinian made available for farmers during the dry season from January to March (Mark, 1982b). Rota has a water system that 20 farmers are using and Kagman Station on Saipan provides irrigation to nearly 35 acres and 11 farmers from a well on the Station grounds (Mark, 1982b). All of these systems are reported as needing improvements and expansion, but funding is a big problem. In Guam, municipal water is available to farmers for irrigation at 25% of cost, but supplies are insufficient (Khamoui, 1985). No other areas have any type of irrigation systems operating at present, although infrastructure-canals and ditches- are still left from Japanese times on some Micronesian islands. Water and irrigation are needed to increase productivity, especially on the dryer islands, but the very high cost must be justified by actual anticipated usage as well as perceived production increase to be derived from the system. In most cases, construction of irrigation systems will be limited to large scale farm development projects on new lands. For the present, urban water needs will also compete strongly with agriculture keeping prices high.

Taking into account the existing situation in U.S.-affiliated islands-lack of water storage and distribution systems, limited capital, and sloping land, drip irrigation seems to hold the greatest possibility for future development. Flood irrigation will continue to be important- especially for taro production. Until farmers in other parts of Micronesia are convinced that capital investment in irrigation is worthwhile, most commercial farming will continue to be rainfed.

Greenhouse, Hydroponic, and other Container Cropping:

Among the most intensive systems of commercial crop production are greenhouse, hydroponics, and container cropping. These production technologies hold the greatest promise in areas where fresh vegetables are in high demand, but soils are not productive, as in urban areas, or on atolls, where high alkalinity and saline conditions preclude standard cultivation practices. They are also promising for the production of some high-value crops that are limited by disease and nematodes.

Greenhouse technology was developed in the temperate zones to produce fruits, vegetables, and flowers during the cold winter season. In the tropics, the purpose of a greenhouse differs in that instead of controlling temperature, it allows farmers to control irrigation and disease. Many crops (ie. tomatoes), and most young seedlings, cannot be grown under existing heavy rainfall, as they are very susceptible to injury and disease. By growing these crops in a greenhouse, foliage can be kept dry and soil sterilized. It is also possible, by the use of canvas dark cloth, to simulate short day lengthes, such making it possible to grow such crops as bulb onion, that are day-length sensitive.

Greenhouses in the tropics usually have only roofs, and these are usually vented to let out the excess heat that builds up under the tropical sun. All of the government agricultural stations have greenhouses, mainly for seedling propagation for later field transplant. The roof allows fertilizer, chemicals, and water to be applied with great precision, producing healthy plants. At PATS, a 50' X 100' greenhouse was used for growing tomatoes for a number of years. The project was finally stopped because of the high labor need (the entire soil of the greenhouse had to be sterilized after every production run) and the relatively low demand for tomato (Soucie, p.c., 1985).

Bambu Foods, a subsidiary of Wa'ab Transportation Co. in Yap also runs a greenhouse about 75' X 175' producing vegetables with some success (Acker, p.c., 1985). They reported initial problems with too much heat build-up but after they modified the roof with vents. there was no more problem. They are planning to use the roof as a water catchment to collect irrigation water. Bill Acker, manager, claims vegetable production is extremely productive under glass in Yap, but the author would add that the high capital costs of building a greenhouse would most likely limit it's use to only the most high-value vegetable crops.

Shadehouses are also used throughout Micronesia, especially for tree and perennial crop propagation. The shadehouse consists of a wooden or metal frame covered with wood slats or fine netting or shade cloth which is commercially available. Shadehouses have the dual advantage of subdued light, important in rooting of perennials, and lower temperatures. Shade house modifications can have other uses, too. The author observed 2 acres under shade being used to grow lettuce, a cool-season crop that cannot normally stand tropical heat, on Guam in 1981. The success of the project is not known.

Hydroponics is a totally controlled system where plants are grown in a sterile, artificial media- generally sand, perlite, gravel, etc., with a pre-mixed nutrient solution being continually pumped throughout the system, usually inside of a greenhouse-type structure. Hydroponics was used to produce food for soldiers stationed on atolls during WWII (Gruelach, 1968). Proponents of the system claim up to 30% faster growth and 5-15 times higher yields, mainly due to close spacing and no competition for nutrients. With proper management, the system can be totally insect, weed, and disease-free. Jim Duffy, owner of The Gardens Hydroponic Farm on Majuro, grows cucumbers, tomatoes, and peppers commercially (Duffy, p.c., 1985). He grows in 100' long beds, 8 inches deep, lined with plastic, and uses a pre-formulated nutrient solution he imports from the U.S. His main problem has been in securing supplies, and some diseases and nematodes. There are at least 6 hydroponic farms currently operating in Guam, with tomatoes being the major crop grown. Khamoui (1985) claims hydroponics is an especially valuable technology for Guam because labor is in short supply, soils are poor, and land values are high. There is also one hydroponic farm on American Samoa growing tomatoes (Vargo, p.c., 1985). Intensive management is necessary for the system's success, and relatively high costs compared to soil cultivation restricts use of this technology to high-value crops. Also, availability and purity of water could be a problem in some areas (Khamoui, 1985).

Other types of container cropping are also possible, again mainly for urban areas or on atolls. F.W. Martin (1981) of the Mayaguez Institute in Puerto Rico suggests that numerous vegetables, especially the leafy-green types, can be grown in old milk cartons, cans, etc. as long as containers are 1 gallon or larger. Soil fertility must be maintained and as much of the plant as possible must be used to make it worthwhile.

There is some commercial production of ornamental plants for the local market on Guam, with several nurseries and retail outlets reported to be selling locally produced ornamental plants. Dr. Sengupta, with whom the author visited at at the University of Guam in 1981, did a great deal of work on ornamental crops development (Guam CES Annual Reports, 1980, 1982). There may be other possibilities where there are enough expatriates to provide some sort of demand.

Other Technologies:

Commercial crop development is dependent on a number of factors, and effective pest control is a major constraint on production. Weeds, rats, insects, nematodes, and diseases are all serious problems facing Micronesian farmers. Weed control alone is estimated to take up nearly 60% of farm labor in tropical areas (Wijewardene, 1984). Pesticides have been introduced, but their inherent dangers to users, as well as their unknown affect on the local environment, are causes for concern. A purely chemical approach can only lead to environmental degradation and health hazards, especially when farmers are not properly instructed in pesticide use. In Guam and American Samoa, the emphasis in pest and disease control is through Integrated Pest Management (IPM), where cultural, biological, and chemical controls are combined to give effective control, and chemical measures are used only as a last resort. There have been several successes using this approach on the two islands (Barcinas, Vargo, p.c.s, 1985, Guam CES Annual Reports, 1979-84). In the rest of the islands, pest control is generally less developed, mainly due to a lack of trained personnel.

Fertilizer is another important input in commercial agriculture. In traditional systems, nutrients are allowed to cycle within the system, and very few nutrients are removed by harvest, etc. In commercial technologies, especially monoculture, these natural cycles are broken, and there is a resultant nutrient drain on the system. Introduction of additional nutrients is then needed, either through manure, organic fertilizers (sea cucumbers, sea weed, dead grass and leaves, compost), or commercial fertilizer. Because many soils in the U.S.-affiliated Pacific islands are relatively nutrient poor due to leaching, erosion, and other factors (SCS Soil Surveys, 1982-83), the need to use fertilizer to obtain commercially acceptable yields is even more imperative. A number of fertilizer trials have been carried out on all the islands, and the use of fertilizer is fairly widespread. It should be remembered that soils vary widely from island to island and even between various areas on an island. Advice on fertilizer applications should be based on local experiments with various crops on the different soils, as well as on soil and foliar analysis (Buringh, 1979). There is also some concern that widespread fertilizer use can have negative effects on groundwater (Khamoui, 1985). More research needs to be done in this area.

Adequate soil testing to determine nutrient defiencies is limited to Guam, where a soils laboratory was set up by the University of Guam in 1975 (Mark, 1982a). Few of the other islands are currently making use of this valuable service. The U.S. Soil Conservation Service has also recently completed comprehensive soil surveys for all of the islands except the CNMI, and these can serve as valuable tools if used properly. Most of these surveys are still sitting in boxes at the respective local agriculture departments, and their further use will depend on adequate training of local personnel.

More work also needs to be done on other methods of maintaining soil fertility, such as green manuring, intercropping with legumes, fallow periods, and crop rotations. Proper liming of soils is another area that needs development, especially on the volcanic high islands where soil acidity is a major production constraint.

Salt is another production constraint, especially on the atoll islands and near the shores of the larger islands. Much has been done on Tarawa, Kiribati, in investigating salt tolerance and technologies to minimize salt effect on crops. (Soucie, p.c., 1985). Rev. Soucie, in his book "Atoll Agriculture for Secondary Schools," (1983) has outlined a variety of strategies, including raised beds, windbreaks, organic matter addition, and drip irrigation, which minimize salt damage on crops. He has also prepared a list of salt-tolerant crops to grow on atolls. (See Appendixes 1 & 2). Many local crops, such as coconut and breadfruit show some salt tolerance (Soucie, 1983.)

2. MAJOR CROPS

Food Crops:

Most commercial production at this time centers around vegetables and copra, along with a small amount of traditional crops that find their way to market- banana, breadfruit, taro, coconut, sweet potato, cassava, and occasionally yams. While much can be done to improve production of local crops- new varieties, improved husbandry, etc., it is doubtful how much the local market can handle as most consumers are also producers. Only expatriate workers and a few urbanized locals make up the market on most islands, and even on Guam, where many people buy a large percentage of their food, most prefer imported produce and food products to local produce. Possibilities for export are also small. While development of this sector is important to local food supply and nutrition, future commercial growth is limited by the amount of local demand and competition with imported food-stuffs. At the same time, this sector must not be overlooked, because of the great affect increased food production can have on the local economy, especially through import substitution. Nutrition is also improved through expanded consumption of local products. Such federal programs as the School Lunch program and the Food Stamp program (currently only on Guam and Saipan) can add to the local demand for food crops, especially when they are modified to provide a greater use of locally produced food, as with the 25% local produce provision in the Food Stamp program recently extended to Saipan.

Spice and Specialty Crops:

With the small size of Micronesian land holdings (usually less than 5 acres), relatively high labor costs compared to the rest of the Pacific, and general high expectations of farm financial returns,[8] spice and specialty crops seem to hold great potential for future commercial development. Beginning with Dr. Oshino during the Japanese Mandate, numerous spice, fruit and specialty crops have been introduced into Micronesia, among them, allspice, nutmeg, pepper, vanilla, ginger, and coffee (Hadley, p.c., 1985).

In Pohnpei, black pepper was introduced in 1959, and has become an increasingly important crop for the island's farmers, with nearly 70 farmers growing from 1/4 to 1 acre or more at this time (Loren, p.c., 1985). The acreage being grown has nearly doubled in the last 2 years. Nutmeg is also being propagated from 6 trees growing at the Ag. Station in Kolonia left over from M.N. Sprout's introduction from Irian Jaya in the 1960's (Hadley, p.c., 1985). The author has observed ginger being commercially grown at the Protestant Mission at Ohwa. All these spice crops give a high return to labor and management and can be profitable in small plantings. Coffee is being grown in the Sokehs area, being propagated from trees left over from a Japanese plantation in the area, and the Agriculture Division is investigating the possibiltiy of bringing in high-yielding varieties from Costa Rica (Veratau, p.c., 1985). The Japanese have expressed interest, as has Fiji, in the possibility of importing Sakau or Kava (Piper methysticum) from Pohnpei in the near future (Lorens, p.c., 1985, also see appendix 4). Other local beverages are being investigated for commercialization. Spice and specialty crops are very promising for the future of Pohnpei, as in other U.S.-affiliated islands, with many possibilities for tourist sales and export (See Supplement, "Potential Spice, Specialty, and Essential Oil Crops for Pohnpei, F.S.M.").

It must be pointed out, though, that because of the extremely small proportion of the world market that any U.S.-affiliated island could control, due to small land area, sales of spice and specialty crops should always aim for the gourmet market, where small quantities of high quality product can demand high prices. This entails extremely strict quality control and processing standards, which must be handled by the government for the time being. Black pepper from Pohnpei has run into many recent problems because of poor quality due to a poorly managed farmer's processing group and some irresponsible exporters trying to make quick profits. Pohnpei State government has now made plans to repossess the government-owned processing equipment, and set it up at the State Agriculture Station so that it can be more closely supervised (Lorens, p.c.,1985).

Oil Crops:

The major oil crop in Micronesia is and will continue to be the coconut, from which copra is made. There are copra oil processing plants on Majuro, Moen (Truk), Palau, and Pohnpei (Sam, p.c., 1985). Yap is in the process of building their own plant (Falanruw, p.c., 1985). On Pohnpei, the plant, Ponape Coconut Products, has developed a line of products- laundry and bath soap, dish soap, cooking oil, shampoo, and marakeiso (body oil), for the local and tourist market (See Appendix 5 & 6). The plant on Truk and Yap will offer similar products, mainly for local import substitution. It has been found that processing greatly improves returns to copra growers, while at the same time providing a measure of import substitution, compared to exporting raw copra.

Other potential oil crops, for example the oil palm (*Elaeis guinensis*), can also be grown. Varieties of soybeans for the humid tropics, developed at IITA in Nigeria, are being tried at PATS on Pohnpei.[9] It is doubtful if any of these crops hold any potential for further development, except in the development of local animal feeds. The small volume of oil produced because of the small land area of Micronesia, would put the farmers at the mercy of highly fluctuating world prices, and would probably not be economical. If the price of imported oil rises again, or supply to Micronesia were slowed down, some local production of oil crops might become feasible, mainly for import substitution. Experiments at PATS, in conjunction with the DOE, have shown copra oil to be an excellent substitute for diesel oil (Girdley, 1983), but with copra oil costing almost $4.00/gallon, compared with $1.50 for imported diesel oil, there is not much incentive to use local oil at this time (Sam, p.c., 1985). *Copaifera langsdorfii*, a tree that grows wild in the Amazonian jungle, has also been shown, when tapped, to produce large quantities of an oil that could substitute for diesel oil. The seeds were introduced to PATS, but they did not germinate.

Essential oil production is another under-developed resource for local island farmers. Several of the local and introduced plants can undergo extraction to produce high-priced essential oils, which can be used in soaps, perfumes, etc. One tree that grows wild on Pohnpei, Ylang-ylang (*Cananga odorata*), has been successfully processed at Ponape Coconut Products at PATS, and samples of the oil, Oil of Ylang-ylang, have received promising reception in Paris and New York (Sam, p.c., 1985). PATS is currently developing agronomic practices for the tree to increase and ensure production. Other crops, such as *Fragraea sair* and lemon grass will also be tried, and other potential crops could be introduced.

Fruit Crops:

With increased tourism in Micronesia, and a greater nutritional awareness among natives, tropical fruit crops offer increased possibilities for commercial development. Guam has developed a small pineapple industry in the last five years, and Saipan is following suit. Kosrae exports citrus throughout Micronesia. Other possibilities exist on all the islands, especially with pineapple, avocado, papaya, guava, passionfruit, soursop, mango, citrus, and banana. Pohnpei exported $50,000 worth of local varieties of banana to Guam in 1983. Improved varieties and cultivation practices could be introduced, and propagation, including budding, grafting, and air layering could be carried out by the local Agriculture Divisions. The Department of Agriculture on Guam and the Land Grant Program in American Samoa have been involved in introducing new fruit and nut crops to their respective islands, and also in propagation of promising varieties for local farmers (Mark, 1982a, and Barcinas, Vargo, p.c.s, 1985). Last year, the American Samoa Land Grant Program sponsored an ambitious project where 500 temporarily laid-off workers from the tuna fisheries were employed to clear and plant 200 acres in coconut, banana, and fruit and nut trees, including citrus- orange, lime, pommelo, grapefruit, and macadamia, rambutan, surinam cherry, and avocado (Vargo, p.c., 1985). Growth data and pest damage are being recorded by Land Grant staff.

Overproduction of fruit crops can be handled by the making of juice, which can be bottled or used in the production of ice fruit juice that is currently popular in areas that have refridgeration. Suitable small-scale juicing machinery is commercially available, and is being employed on other Pacific Islands (Barcinas, p.c., 1985). Yap has used the drinking coconut, through a successful government radio campaign, to replace large amounts of imported canned beverages, and other islands could follow this example.

Other Crops:

Other crops can also be developed into commercial enterprises. Development of local livestock feeds is a high priority on all the islands, and this could increase demand for local production of several crops, especially cassava, corn, and soybeans. Ornamental crops have already been mentioned as a possible commercial product. On islands where there is a large population of expatriates, the Norfolk Pine could be successfully be grown a Christmas trees (See Appendix 7).

3. OTHER AREAS AFFECTING COMMERCIAL CROP PRODUCTION:

Marketing

The key to successful commercial crop development is markets. With few exceptions, markets in the U.S.-affiliated islands have been characterized as being generally small and disorganized under the American administration (Mark, 1982a). Many attempts have failed, due, at least in part, to the fact that production could not be sold, or that price was not high enough (Soucie, 1971, Hadley, p.c., 1985). People involved in marketing generally complain that it is easier to depend on imported produce that has uniform quality and is always available, rather than depending on local production, which at best is of marginal quality and produced at infrequent intervals. Farmers complain that markets don't buy enough and that prices are generally too low to be economical. Both sides are somewhat justified. Farmers are too many and too small-scale to ensure regular production and uniform quality, and markets are many times poorly managed and unconcerned with the farmer's well-being. Also demand for crops are mainly by the small expatriate population, as most consumers are also producers in the traditional subsistence system. These expatriates may often prefer imported produce to local products.

Almost all markets are located in the district centers, so the further a farmer is located from the center, the less chance he has to participate in commercial farming. Transportation and infrastructure further complicates marketing. Some areas, especially the outer islands, are still served only once every few monthes by government ship. Farmers nearer the district center enjoy much greater access to markets, but their generally small-scale of operations, due to small land area and lack of capital, makes for rather sporadic marketing activity.

Export markets for most crops are also weak or non-existent. Small amounts of some crops, such as citrus from Kosrae, banana from Pohnpei, and vegetables from the CNMI (to Guam) are exported within Micronesia. Transportation is generally poor between islands, and this inhibits successful inter-island and export marketing efforts (Mark, 1982b). Copra continues to be the major agricultural export for the U.S.-affiliated islands, although black pepper from Pohnpei (Lorens, p.c., 1985) and taro from American Samoa (Mark, 1982a) have been exported occasionally. Small quantities and sporadic production, along with quality problems with pepper, have led to the curtailment of these exports. Most movement of food items tends to be into the area, with the F.S.M. alone accounting for over $5 million of food imports (1/2 of total imports) for 1982 (Henry, 1983). American Samoa imported nearly $17.2 million in foodstuffs for 1983 (American Samoa Economic Development Program (EDP 2), R. Henning, 1985). Food imports into other areas are similar, with Guam having the highest amount of food imports due to it's large population.

Export markets can be improved by increased cooperation between the local government entities, especially through coordinated market development between the U.S. affiliated island governments, and also with other governments, especially the U.S. and Japan. Guam has investigated several export possibilities, but nearly all are currently unfeasible, mainly because the

Japanese government bans many food items from Guam and Micronesia because of the fruit fly, which is known to be in the area. Adequate fumigation facilities and some cooperation by the Japanese government could improve the situation immensely. Several recent shipments of Pohnpei pepper have also been banned on the U.S. west coast because of insect infestation (Veratau, p.c., 1985).[10]

Another major obstacle facing the U.S.-affiliated islands is the economies of scale and the relatively lower production costs of prospective competition for export markets, most notably Taiwan and the Phillipines. American Samoa has also found that it cannot compete with it's neighbors, Western Samoa and Tonga, for the Australian and New Zealand market (Mark, 1982b). In Guam, locally produced pineapple enjoys a price of $0.75/lb. on the local market, while in Japan, it would have to compete with Phillipine pineapple being landed at $0.24/lb., well below the current estimated cost of production on Guam (Khamoui, 1984b). Other crops face similar competition.

Plasch, quoted by Khamoui (1984b), states that "an export commodity must be appealing to overseas buyers on the basis of exceptional quality or uniqueness, or it must be capable of being produced at very low cost relative to domestic producers in the importing country, at the same time competitive with other exporting countries." Since it is doubtful that the small islands of Micronesia or American Samoa can compete price-wise, the only feasible alternative is to develop the quality aspect for potential exports. This has been the selling point for Pohnpei pepper, although recently, quality has fallen drastically, due mainly to mismanagement of the local processing cooperative. Other spice and specialty crops, with their high value per unit and relative imperishability after processing, would lend themselves to quality control. Their high value would also enable them to be shipped via relatively expensive air freight, further ensuring quality and freshness. Adequate fumigation facilities on exporting islands would help much in this area, as well as an increased role by the local government in quality control via regulations, inspections, and strengthened quarantine services. Dr. Shelley Mark (1982a) of UH-HITAHR has identified the following as important areas in market development:

1. Organization and administration of cooperative associations.
2. Quality standards.
3. Market information and production planning
4. Price supports and other market intervention schemes to stabilize prices.

Cooperatives:

It was recognized early on in the U.S. administration of the islands that one way to coordinate a number of small-scale producers, and have enough aggregate production to develop markets, was through the organization of cooperatives (Zaiger and Olter, 1963?). In the early 1960's cooperatives were set up in nearly every area. Many failed, and today there is a general distrust of cooperatives because of this (Lorens, Hadley, p.c.s, 1985). Still, cooperative effort is the basis of nearly all island activity, and people work together daily in food production, building construction, and fishing. The concept of cooperative activity should be easily assimilated by Micronesians. Most of the cooperatives that failed, probably did so because of poor management (especially of funds) and insufficient member education.

Today there seems to be a minor resurgence in cooperatives. Cooperatives can help in transport of inputs and produce, organization of market outlets, timing of crop production, ownership of farming and processing equipment, provision of credit to members, obtaining technical services, providing political pressure for land reform, protective tariffs, and extension services, and educating members. With the large number of farmers, wide range of commodities produced, and relatively small populations in the U.S.-affiliated islands, it seems that cooperatives could play a strong role in development efforts (Mark, 1982a). The key to successful cooperatives is honest, knowledgeable, and hard-working management, combined with active member education.

Several cooperatives, including the East Coast Farmer's Coop in Palau, now have their own refridgeration and marketing facilities. Cooperatives are also thriving on Guam and the Northern Marianas. In the last year, no less than 7 grass-roots farmer's organizations have been formed on Pohnpei. The government must recognize these cooperative organizations and encourage and nurture them through supportive government policies (ie.- market development, processing facilities, and financial help) and help in cooperative education of members and management.

Research and Extension

Research and extension, which have been key components in nearly successful agriculture development scheme, have for the most part been neglected in the U.S.-affiliated islands. There are experiment stations on nearly every major island, where the Agriculture Departments are headquartered, and research and extension takes place. In most areas, key research personnel have been mainly expatriates on short-term contracts, with a recent switch towards local indigenous staff.[12] A continuing lack of plans and priorities, along with a general lack of understanding of local culture and constraints by expatriates, combined with lack of training, education, and experience among local personnel, and generally limited budgets, has greatly hindered local research and extension activities. Work has been further hindered by the lack of records of previous research and activities, causing much basic research to be lost over the years.

The introduction of the Land Grant Program to Guam in 1972 and to American Samoa in 1975, has improved this situation considerably. Federal monies have been used to hire on specialist staff, further educate and train indigenous personnel, establish improved facilities, and development college-level agriculture curriculums. Since 1972, Guam has established the College of Agriculture and Life Sciences (CALS) at the University of Guam, the Guam Agriculture Experiment Station, with 2 research stations, and Cooperative Extension Service (CES). These institutions are cooperating together to improve research and extension. The Guam Department of Agriculture has taken on more of a regulatory and farmer service role (Barcinas, p.c., 1985). In American Samoa, the pattern has been similar (Vargo, p.c., 1985). There is every indication that the recent extension of Land Grant Programs to the F.S.M. College of Micronesia will be beneficial to the existing situation in the area.

Research should be increasingly directed towards small-scale family farmers. Much previous research has been copied from Hawaii and the U.S. mainland, where high levels of management skills, capital, and other resources are available to take advantage of new crops and technologies. This is not the case in most of the U.S.-affiliated islands. With currently limited research staff and funding, efforts should concentrate on identifying priority crops, and then developing high production packages for these crops. Cost-Benefit analysis could be used in identifying potential crops (Fairbairn, 1977).

A great deal of effort should be made to develop regional cooperation between islands and with other South Pacific and Asian nations. University of Hawaii-Hawaii Institute of Tropical Agriculture and Human Resources (UOH-HITAHR) has suggested that it would be cost-effective for the USDA to support cooperative research and development endeavors between themselves and local island governments (Mark, 1982a). HITAHR is currently carrying out taro silage research in American Samoa and has completed some nitrogen studies on Guam. American Samoa is fortunate to be a participant in the South Pacific Commission and as such benefits from that organization's agricultural research programs. The University of the South Pacific at Alafua is expanding it's work in the area of agricultural education and extension, and the UNDP is running numerous research projects throughout the South Pacific. The U.S.-affiliated islands should become much more involved in these programs.

Statistical research is also a much overlooked area in the U.S. islands. A great deal of current information for the area is based on guesses, and there are very few regular agricultural data collection systems in operation. Statistics are extremely neccessary for planning, feasibility studies, decision-making, and evaluation of progress. Dr. Te'o Fairbairn (1977), an SPC economist, suggests that as a minimum, the following data needs to be collected:

1. Commodities being produced and present production.
2. Corresponding inputs.
3. Land under use.
4. Size and distribution of farms.
5. Employment.
6. Volume and allocation of agricultural loans.
7. Level of subsistence production.
8. Prices of farm inputs and outputs.

Extension is a big need in all the islands. With the exception of Guam and American Samoa, extension personnel are almost universally poorly trained and educated. Links between research and extension are few, and support services, even transportation, are nearly non-existent. The Land Grant Program has made notable improvements in Guam, where staff have been encouraged and assisted in furthering their educations (Barcinas, p.c., 1985). Agents are much more involved in research, both tactical (research station) and operational (on-farm), providing a much more effective "bridge" between researchers and farmers. Further research is needed in transfer of technology, research results, and other information to farmers.

Guam has the most extensive information and extension service, with combined CALS, GAES, CES, and DOA efforts offering farmers government leased land, subsidized water rates, crop forecast and market news (Appendix 3), crop insurance, insect and disease control and eradication, sale of vegetable and fruit tree seedlings, soil testing, management assistance to cooperatives, applied research and extension, pilot and demonstration projects, a farmer's market, and a revolving fund (Mark, 1982a).

4. OTHER MAJOR CONSTRAINTS

There are three major constraints to commercial agricultural development in the U.S.-affiliated islands, that although previously mentioned, deserve more attention. These are land, labor, and capital, which are all major prerequisites for successful commercial agriculture.

Land

Besides physical characteristics- slope, low fertility, etc., their are several social factors to consider when looking at the land resource in the U.S. islands. Traditional systems of land tenure have revolved around clan or tribal ownership. Even in Micronesia, where the Germans instituted a system of private ownership, land-use is still controlled to some extent by family heads or chiefs. In areas where private ownership prevails, land parcels are generally small (less than five acres), due to subdivision to heirs, making large-scale farming activity impossible. The effects of the German land distribution has resulted in large land areas being held by local governments. as in Pohnpei and Palau. The local government also owns large tracts in Guam. The U.S. military, as a result of WWII, holds large areas of land in Guam, Tinian, and the Marshalls.

In nearly all areas, land-use is further restricted by incomplete surveys and titles. Laws in all areas except Guam restrict land ownership to native citizens. Many areas do not have property taxes, and cannot easily introduce them due to the traditional concept of land as a birthright. There is little discouragement for land-owners that let their land sit idle. Leasing practices, because of unclear laws and difficulty in securing a large, contiguous land area, are generally unsuitable to large-scale agri-business.

There is a need in all areas for more effective land-use controls, with an appropriate tax policy for agricultural lands. Increased controls may increase land-use for farming, especially if extension and research are simultaneously improved, as owners can be penalized for not using their land for production. Effective leasing laws need to be developed. Guam has two land-lease schemes to encourage agriculture development (Mark, 1982a, Khamoui, 1985), and other areas are pursuing homestead or leasing activities.[13]

Labor

Agricultural labor shortage is a problem in several areas. In general, there is a low esteem for farm work, and wages and benefits are low compared to other types of employment. Guam has considered importing foreign labor under the Federal H-2 temporary alien program, but the Labor Department apparently blocked this (Mark, 1982a). Since GovGuam was granted the authority to certify and import alien workers in 1984, they may reconsider this proposal (Khamoui, 1985). In American Samoa, much of the agriculture depends on "aiga", family members from Western Samoa, and Taiwanese and Koreans who have jumped ship at Pago Pago (Mark, 1982a, Vargo, p.c., 1985).

The question of whether or not to import foreign labor is a difficult one. Agricultural industries such as Hawaii's were built with cheap foreign labor, but there can be resulting social tension when large numbers of foreigners are imported into a relatively closed society, as in many of the U.S.-affiliated islands. Pohnpei has rejected two proposals, one to bring in Vietnamese refugees to grow rice, and one from Hong Kong businessmen, for these reasons (Lorens, p.c., 1985). On the other hand, Khamoui (1985), argues that importing labor is better than importing food- the agricultural industry will develop, dependence on imported food is reduced, and foreign workers generate tax revenues through payment of taxes on their wages. Making agriculture more profitable through increased research, development, and extension might be the preferred alternative.

Capital

Recently capital has become increasingly available, mainly through the establishment of government development banks in each island entity. In Micronesia, the banks, one each in the CNMI, Palau, F.S.M. and the Marshalls, are the result of a 1971 appropriation of $5 million by the U.S. Congress to the TTPI government for economic development. This money was at first administered through the Economic Development Loan Fund (EDLF), which was frozen in 1977 due to numerous problems, mainly difficulty in collection of overdue loans (Mori, p.c., 1986). In 1979, the TTPI requested that each political entity- CNMI, Palau, F.S.M., and the Marshalls, set up their own development banks to manage the remaining funds, which were divided between them (Mori, p.c., 1986). The F.S.M. Development Bank was chartered by the F.S.M. Congress in 1979, and began operations in 1982 (See Appendix 8).

The biggest problem in the past has been with repayment, which Mori (p.c., 1986) blames on a "grant" mentality among most Micronesians, perhaps due to development strategies in the past. 14 He also is worried about financial constraints on the bank- according to him, all money is now loaned out, and no further funding from the government has been forthcoming. Also, he feels the bank is extremely understaffed, and so far they have not been able to keep close account or make adequate progress checks on the various bank subprojects. It remains to be seen how effective the new government development banks will be in stimulating development and in collecting loans.

Concentration on farmer training in the areas of planning, budgeting, accounting, and other farm management practices would greatly improve commercial agriculture in all areas. This could be taken on by the respective banks in conjunction with the agriculture departments on the islands.

5. SUMMARY:

Technologies are available and crops have been or could be introduced that are highly conducive to commercial production. The Federal government along with the local government entities must overcome the constraints on commercial agricultural development that have been made clear in this paper. Recommendations for action are suggested in the following section.

6. RECOMMENDATIONS FOR ACTION:

Throughout this report, it seems clear that the U.S. government has never really made a serious effort to develop commercial agriculture in the U.S.-affiliated islands. Policies and plans, both at the federal and local level, have not been clearly defined. Federal programs and financial assistance have stressed physical and social infrastructure, along with general financial support to the island governments. Very little has gone into agricultural or other economic development. The Federal and local governments must realize that successful agricultural development, although entailing significant investment, will in the long run result in less dependence on Federal assistance.

1. Federal support should consist of:

a. Extension of USDA and other agency programs that give greater assistance to farmers, especially those not currently in the islands- Under the Omnibus Territorial Act of 1980 (P.L. 96-597), the Secretary of Agriculture can extend, at his discretion, extend USDA programs to the U.S. Territories and can also appropriate funds, as necessary, to carry out this provision. U.S. Territories are also eligible to participate in DOE, DOI, and other federal programs under the Water Resources Act of 1974 (P.L. 93-251). Several programs have been extended to the U.S.-affiliated Pacific islands, but others such as soil conservation, crop insurance, and farm loans, which could also benefit commercial agriculture, have not yet been introduced to the area. It is the opinion of the author that a great number of local authorities are unaware of the many programs for which they are eligible.

b. Making changes in School Lunch, Food Stamp, and other federal food programs, to give more support to local agriculture- The School Lunch program has been introduced into all areas. It is estimated that more than 1 million pounds of food from the mainland are imported into the islands under this program, much of which could be grown locally (Mark, 1982a). Some local produce is purchased, but the funding for local purchases could be increased. A simultaneous development of adequate storage and processing facilities would greatly increase use of local production. There is also some concern that the high prices being paid for small amounts of local produce through the program are creating a situation that discourages other local marketing efforts. Increased use of local foods would also improve nutrition among school children.

The Food Stamp program has been introduced into Guam and Saipan. In Saipan, the program has a 25% local food purchase provision, and there are indications that Guam might benefit from a similar modification in their current program.

c. Increasing direct assistance for local agricultural infrastructure development- Direct funding for infrastructure development has come mainly through the federal Economic Development Agency, whose programs are currently being reduced. Other sources of direct funding should be made available for secondary roads, port expansion, quarantine and fumigation facilities, irrigation, and refrigeration and processing facilities.

d. Increasing assistance in research, development, and extension activities- Programs such as the Land Grant should be encouraged to take over research and extension activities from the local DOA's. Efforts should be made to identify major problem areas in agriculture and corresponding efforts made to solve them using federal assistance programs. Various programs have been discussed, such as crop insurance, soil conservation, and farm loans, that could be introduced to complement Land Grant programs.

Note: In the Compact states of Belau, F.S.M., and the Marshalls, most federal program money will be discontinued and replaced by block grants. The local governments will then have to decide whether, and at what level, to support the above programs, should they wish them to continue.

2. In line with the 1984 proposal by the Pacific Basin Development Council, the U.S. Congress should support the formation of a task force and working committee to investigate agricultural development possibilities for the U.S.-affiliated islands. The task force could be made up of representatives from the USDA, DOI, local economic planning departments, farmer's groups, UH-HITAHR, UOG-CALS, a prominent international agribusiness firm, a major financial institution, and local development banks. This group would review major constraints on commercial agricultural development, and investigate Federal and local strategies to overcome them. The committee's

recommendations could be used to develop a coordinated regional agricultural development plan.

3. The U.S. Congress should assist local governments in product and market development, especially in areas such as eradication of the fruit fly, opening up the Japanese and Australian markets, and certification and special trade provisions to facilitate entry of products from the U.S.-affiliated islands into the U.S. The Federal government should also assist the local governments in coordinated marketing development, to eliminate competition between island entities. The U.S. military should also increase it's consumption of local food products.

4. Local government agencies should allow the Land Grant program to assume research and extension activities to avoid duplication of services. The local DOA's can put more emphasis on regulatory (quarantine, quality control) and farmer services (local market development and information, statistics, farm inputs, etc.) The Land Grant program can absorb various local research and extension staff and further train them, as well as financial assisting the the local DOA's with certain projects. A close working relationship must be built between the federal and local agencies. In the Compact States, it is hoped that the local governments will pick up the Land Grant program if it is no longer to be supported by federal monies.

5. Increased local efforts should be made to identify possible commercial crops on each island. This paper mentions spice, specialty,

and essential oil crops as promising development opportunities for the U.S.-affiliated islands. Selecting target crops may be a workable strategy, and development of high production crop packages has been mentioned. Efforts must be made to introduce superior varieties onto the islands, and then trials should be carried out to determine suitable husbandry practices, expected yields, processing technologies, and production economics. Increased efforts and coordination in extension and marketing programs must accompany commercial crop development programs. Suitable research needs to be done on integrating these crops into the local traditional agricultural systems, as well as intercropping them together to take advantage of the benefits of polyculture.

6. Local governments must reevaluate the current education system. Too much emphasis is put on the attainment of "white-collar jobs, at the expense of technical vocations. Vocational agriculture education programs should be strengthened and expanded and promising high school graduates encouraged to study in technical agricultural fields through government scholarships. Increased scholarships to South Pacific and Asian institutions, where agriculture education is much more appropriate to the realities of Pacific islands, should be encouraged.

7. Agricultural development planning in all islands must be improved. Plans should include an adequate set of obtainable objectives, an appropriate development strategy, provisions for implementation, and a consistent financial plan and budget. Collaboration between governments, perhaps even a federally-

sponsored regional planning approach, would reduce competition and lead to a mutual support and sharing of ideas.

8. Local governments must give more recognition to traditional subsistence agriculture and it's important role in food production and employment of under-utilized labor resources. Commercial agricultural development should complement, not compete with, local traditional systems. The knowledge of traditional agriculturalists should be tapped in chosing and designing technologies for future agricultural development. Many technologies can also be integrated into traditional systems with much success, including new varieties, irrigation, and improved husbandry.

9. Efforts must be made by local governments to clarify land titles and surveys in all areas. Government lands not presently in use should be sold or leased for agricultural purposes, in large enough parcels to make commercial farming profitable. Land taxes should be instituted with appropriate incentives for agricultural use of land, to discourage landowners from leaving their lands idle. Leasing of private land should be facilitated and and made more attractive for agricultural use (ie.- long-term leases, low rents) through appropriate legislation.

10. Increased communication must be encouraged between federal and territorial governments, and between the U.S. islands and other developing area governments and international and regional agencies, especially in the South Pacific. Much has been done in

other areas that is extremely relevant to the U.S.-affiliated island's own agricultural development. The continued reliance on U.S. technologies and experts is inappropriate to the area's unique culture and climate.

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APPENDIX 1

Salt Tolerance of Some Vegetables

High Salt Tolerance	Medium Salt Tolerance	Low Salt Tolerance
arrowroot (H.pH)*	broccoli (MH.pH)	Alocasia taro
asparagus (H.pH)	cabbage, head (H.pH)	banana
beet (H.pH)	cantaloupe (H.pH)	bean (M.pH)
coconut (H.pH)	carrot (M.pH)	breadfruit (M.pH)
kale (M.pH)	cauliflower (MH.pH)	celery (MH.pH)
pandanus (H.pH)	corn (M.pH)	Colocasia taro (M.pH)
papaya (H.pH)	cucumber (M.pH)	radish (M.pH)
spinach (H.pH)	Cyrtosperma taro	
	lettuce (MH.pH)	
	onion (MH.pH)	
	pea (MH.pH)	
	pepper, sweet (M.pH)	
	potato, white (L.pH)	
	squash (MH.pH)	
	tomato (MH.pH)	

**pH Key:* H.pH = the plant can do well at a *high* pH (as high as pH 8.0).

MH.pH = the plant can do well at a *medium high* pH (as high as pH 7.5).

M.pH = the plant can do well at a *medium* pH (as high as pH 7.0).

L.pH = the plant can do well at *lower* pH levels (only as high as pH 6.5 and lower).

Source: Soucie, Rev. Edward A., Atoll Agriculture for Secondary Schools,
PEACE Foundation, New York, 1983.

APPENDIX 2

Combined Rating for Adaptability to Atoll Soils
Based on Salinity Tolerance and pH[45]

Excellent	Good	Fair	Poor
arrowroot	broccoli	carrot	beans
asparagus	cauliflower	corn	cassava
beet	lettuce	cucumber	celery
breadfruit	mustard greens	eggplant	mango
cabbage	onion	pepper, sweet	potato (white)
cantaloupe	peas	pineapple	radish
coconut	pumpkin	sweet potato	watermelon
Cyrtosperma taro (taro pits)	soybean		
Hibiscus manihot	squash		
kale	tomato		
okra			
pandanus			
papaya			
peanuts			
spinach			
tabasco pepper			

Explanatory notes:

(1) It is quite possible to have medium and even low soil salinity and pH on atoll soils. Obviously in these cases the above rating would not apply.

(2) There are soil climatic factors such as temperature, salt spray, irregular moisture, etc., which would seriously affect the performance of some of the vegetables on atolls (e.g., asparagus, peas, lettuce, celery and potato).

(3) Certain types of breadfruit, especially seeded types, grow well on atolls but always this plant must have ground water low in salinity.

(4) *Terminology:* The term *"alkalinity"* refers exclusively to the pH of the soil. The term *"salinity"* refers to the salt content of the soil. Calcareous atoll soils are usually both saline (salty) and alkaline (high pH). Ordinarily a saline soil is only slightly alkaline with a pH value in the range of 7.0 to 8.5 and contains very little absorbed sodium.[46]

(5) The above list was compiled by the author. It is subject to correction and revision.

Source: Soucie, Rev. Edward A., Atoll Agriculture for Secondary Schools,
PEACE Foundation, New York, 1963.

APPENDIX 3

CROP AND MARKET PRICE REPORT

Released periodically by the
Agriculture and Natural Resources
Cooperative Extension Service

College of Agriculture and Life Scienc
University of G
Phone: 734-2

CMPR-1

Mangilao, Guam July 31, 1985

Planting activities continued with long beans acreage increasing threefold over June's total of 3.75 acres. With supply of beans now at relatively high level, the increased acreage could bring just too much beans in the market, come September. Watermelon and cucumbers also bear watching. July plantings totaled 19 and 6.5 acres, respectively, for these two crops. Except for tomatoes, sustained planting was also reported for all other vegetables.

Crops	Total acres planted as of June 30*	Acres planted as of July 31	Estimated harvests for period Sept. 1-30	
			Acres	Pounds
Beans, K.W.	17.00	3.50	3.50	11,550
Beans, Long	41.50	12.50	12.50	41,250
Beans, Wing	1.25	1.00	1.00	3,300
Bittermelon	11.50	3.25	3.25	27,300
Cabbage, Chinese	4.00	-	-	-
Cabbage, Head	17.50	-	-	-
Cantaloupe	25.25	-	-	-
Corn	7.50	-	-	-
Cucumbers	33.25	6.50	6.50	93,600
Eggplant	9.50	0.25	0.25	1,650
Honeydew	4.00	-	-	-
Okra	1.00	-	-	-
Onions, Green	3.75	-	-	-
Pepino/Sweet Melon	19.25	0.75	0.75	6,750
Pepper, Bell	13.75	1.75	1.75	5,775
Potato, Sweet	7.00	2.00**	3.00	27,900
Radishes	3.00	-	-	-
Squash, Zucchini	2.50	-	-	-
Tomatoes	29.75	0.50	0.50	3,000
Watermelon	107.50	19.00	19.00	342,000
All Crops	359.75	51.00	52.00	564,075

* Total planting since October 1, 1984.
** To be harvested in October, 1985.

KATAOKA & CO., LTD.
6-4, TORANOMON 2-CHOME, MINATO-KU, TOKYO 105, JAPAN.
PHONE:(03)502-0251 CABLE ADDRESS:FIKNRE TOKYO TELEX:02224393(FIKNRE J)

APPENDIX 4

Tokyo, 9th September, 198

Sailas
Daniel

Department of Resources and Development
ESM National Government
Kolonia, Ponape
E.C. Is. 96941

Gentlemen:

We are writing this letter with keen interest in the "Sakau" plant which was recently introduced by Japan Economic Journal. We have also come to know through the article of the National Union of July 15 issue that the project of export of the Sakau plant was now in progress.

We have long been established as importers and distributors of foods and beverages of world's leading brands such as Twinings teas, Fortnum & Mason's food products, Van Houten's cocoa products and so on. In order to enrich the existing variety, we are always looking for some new and unique foods and beverages which are gaining popularity in overseas markets.

We have already obtained a prior consent of our Authorities concerned that they allow us to import Sakau subject to the result of analysis of the samples being satisfactory although there is so far no import record of this plant in Japan. We feel there is a good possibility that if we produce the drink using such a mysterious plant as Sakau, it would be well accepted by the Japanese people.

We should be grateful if you would kindly let us know whom we should contact for obtaining more detailed information and samples of Sakau. Of course, it would be much appreciated if you would kindly take the trouble to supply us with the information and samples.

We sincerely look forward to your favourable reply.

Yours sincerely,
KATAOKA & CO., LTD.
K. Inazuka
K. Inazuka
Manager
Product Development Section

KI/nh/mm

APPENDIX 5

Ponape Coconut Products
Post Office Box 39
Ponape, Eastern Caroline Islands 96941

[illegible] PATS, PONAPE
[illegible] ISLANDS

PRICE LIST

DESCRIPTION	ORDERS 1-25 css.	26-50 css.	51 Up css.
aselel Bath Bars" in ellophane wrap-72 bars/cs. et wt.-3.2 oz.	$32.40/cs.	30.96/cs.	28.80/cs.
ath Soap Available in Coral Pink, Pacific Blue, Pearl White, & Sun Yellow			
aselel Bath Bars" in aper wrapper-72 bars/cs. et wt.-3.2 oz.	36.00/cs,	34.56/cs.	32.40/cs.
arekeiso Body/Hair oil" 4 btls./cs. 8.5 fl. oz.	43.20/cs.	38.40/cs.	36.00/cs.
arekeiso Body/Hair oil" 4 btls./cs. 4.0 fl. oz.	24.00/cs.	21.60/cs.	19.20/cs.
aselel Coconut Oil Shampoo" 4 btls./cs. 8.5 fl. oz.	36.00/cs.	33.60/cs.	31.20/cs.
aselel Coconut Oil Shampoo" 4 btls./cs. 4.0 fl. oz.	21.60/cs.	20.40/cs.	19.20/cs.

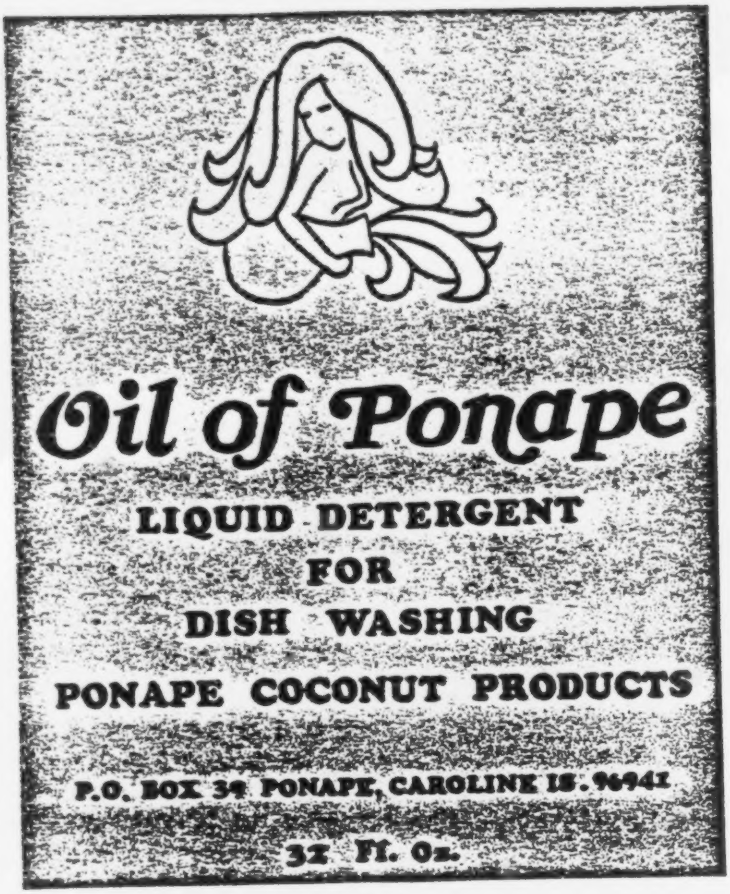
FT PACK- Our products in PONAPEAN HAND WOVEN BASKETS that are attractive reuseable.

DESCRIPTION	ORDERS 1-100 pkgs.	101 Up pkgs.
LARGE: Contains 1 bottle marekeiso(4 fl. oz.), 1 shampoo(4 fl. oz.) and 3 regular size bath soap with mixed colors and scents.	$5.50 ea.	5.25 ea.
SMALL: Contains 3 regular bath soap with mixed colors and scents.	2.95 ea.	2.75 ea.
CARDBOARD GIFT PACK Contains 2-8.5 fl. oz. marekeiso, 2-8.5 fl. oz. shampoo and 8 bars bath soap in assorted colors and scents.	10.00 ea.	9.50 ea.

ALL PRICES ARE F.O.B AND ARE SUBJECT TO CHANGE WITHOUT NOTICE

• MANUFACTURERS & EXPORTERS OF QUALITY HOUSEHOLD PRODUCTS
LAUNDRY SOAP -- LIQUID DETERGENT -- COOKING OIL -- COSMETIC PREPARATION

APPENDIX 6a



Oil of Ponape

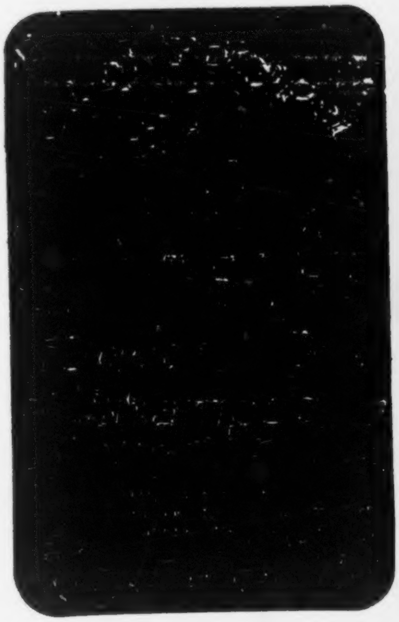
LIQUID DETERGENT
FOR
DISH WASHING

PONAPE COCONUT PRODUCTS

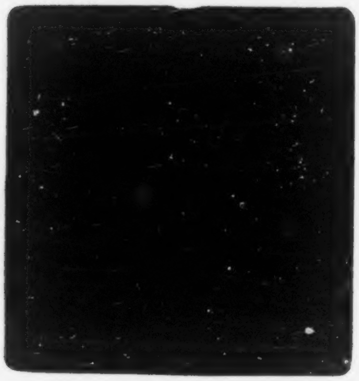
P.O. BOX 34 PONAPE, CAROLINE IS. 96941

32 Fl. Oz.

Dishwashing label

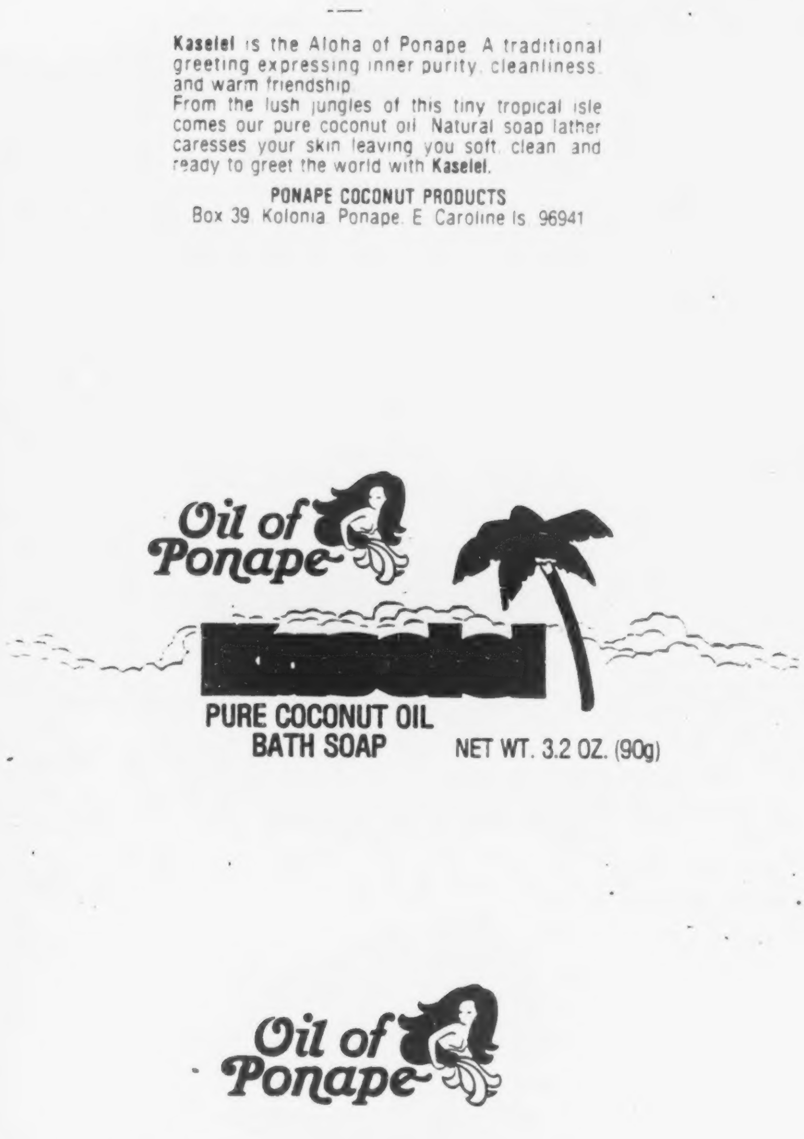


Shampoo label



Back label for both shampoos

Small shampoo label



Kaselel is the Aloha of Ponape. A traditional greeting expressing inner purity, cleanliness, and warm friendship.
From the lush jungles of this tiny tropical isle comes our pure coconut oil. Natural soap lather caresses your skin leaving you soft, clean and ready to greet the world with **Kaselel.**

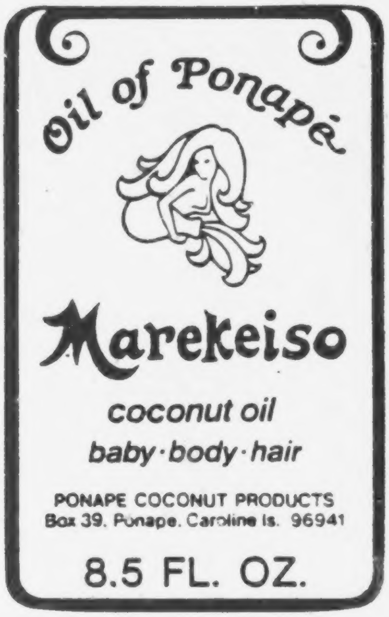
PONAPE COCONUT PRODUCTS
Box 39, Kolonia, Ponape, E. Caroline Is. 96941

Oil of Ponape

PURE COCONUT OIL
BATH SOAP
NET WT. 3.2 OZ. (90g)

Oil of Ponape

Bath soap wrapper



Oil of Ponapé

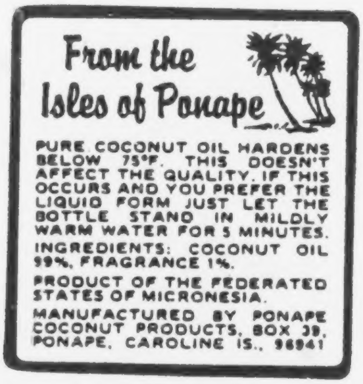
Marekeiso

coconut oil
baby · body · hair

PONAPE COCONUT PRODUCTS
Box 39, Ponape, Caroline Is. 96941

8.5 FL. OZ.

Marekeiso body/hair oil label



From the Isles of Ponape

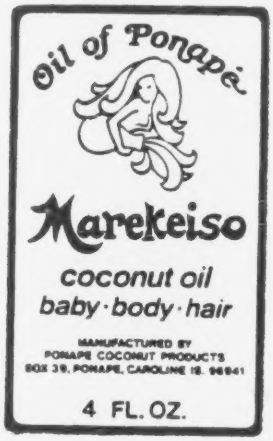
PURE COCONUT OIL HARDENS BELOW 75°F. THIS DOESN'T AFFECT THE QUALITY. IF THIS OCCURS AND YOU PREFER THE LIQUID FORM JUST LET THE BOTTLE STAND IN MILDLY WARM WATER FOR 5 MINUTES.

INGREDIENTS: COCONUT OIL 99%, FRAGRANCE 1%.

PRODUCT OF THE FEDERATED STATES OF MICRONESIA.

MANUFACTURED BY PONAPE COCONUT PRODUCTS, BOX 39, PONAPE, CAROLINE IS., 96941

Back label for both Marekeisos



Oil of Ponapé

Marekeiso

coconut oil
baby · body · hair

MANUFACTURED BY
PONAPE COCONUT PRODUCTS
BOX 39, PONAPE, CAROLINE IS. 96941

4 FL. OZ.

Small marekeiso body/hair oil label

APPENDIX 7

3 PACIFIC DAILY NEWS, Monday, December 9, 1985

A

The Islands

Man focuses work on Christmas trees

195

Daily News file photo

Ivan Desoto, a Yigo farmer, has been experimenting with the Norfolk Pine (seen behind him), as well as other types of pines and cypress in trying to develop a commercially viable Christmas tree for Guam.

By BEN SANTOS
Daily News Staff

Lost amid clay pots and fertilizer bags in the greenhouse, the newly sprouted seeds give no hint of what's to come. The constant care and nurturing of their owner will eventually yield a seedling strong enough to stand on its own in the acre of harsh soil along with the other trees planted years before.

Forgotton for most of the year, the Norfolk Island Pine — not a true pine, but still, it has the long needles and cone shape of fairy-tale pines and long branches that invite an ornament or two — grows willfully slow, fighting off an occasional nest of termites or hosting the few birds seeking a perch in the higher branches.

The Christmas trees, as they are known on Guam, have been a part of Ivan Desoto's patience — the seedlings live in the greenhouse for two years before they can be transplanted — and committment to finding and growing a commercially viable holiday tree for the island.

The Yigo horticulturist's project started 11 years ago with a few seeds from a friend in Hawaii. The trees have grown well at Desoto's Yigo farm, but Desoto is still looking for just the right formula of nutrients and pruning care to produce the right foliage and cone shape desired.

"I originally followed instructions from the University of Hawaii, but I've found I've had to experiment some more. All the information is really basic on growing the trees, but I'm looking to control just the right volume of seedlings to control the growth factor, and then it may be commercially viable to grow trees on Guam for the holiday season."

The Norfolk Island Pine, perhaps named after an island of the same name near Australia, originally came from Australia. It takes six years of growing before any of the trees may be cut, after which time the main stalk will sprout another spire. The pine is known to grow to "over 300 feet with a girth of 3 feet to 4 feet" and is commonly used for lumber in Australia.

Although the several dozen trees are Desoto's experiment and the few that he cuts down go to his regular customers, the kindly grower succumbs to the Christmas spirit every year.

"Sometimes I also get a few families come up here and they just couldn't get a tree for Christmas for the kids and I'll tell you it breaks my heart, I just can't turn them down," Desoto said.

Desoto said he is experimenting with Italian Cypress, as well as one from Arizona, some Black Pine and a type from Israel. "I hope one of these days, I'll have enough information to commercially grow the trees.

"Pines are supposed to be able to survive in real lousy soil. I'm going to keep at it until I find a way."

Trees go on sale this week

For the rest of the homes on Guam, the commercial trees have arrived.

All the major department stores on Guam will have trees for sale; some will start selling today with prices ranging from $14 to $48.

Townhouse, Island Home Improvement, Ben Franklin, Gibson's, and Mark's Department Store will also have fresh trees for sale. Joe Piper of Mark's said the store will schedule the sale of trees closer to Christmas day because the store has no refrigeration system to keep the trees fresh. Spokesmen for a both Ben Franklin and Gibson's department stores said fresh trees should go on sale today.

F.S.M. DEVELOPMENT BANK
PROSPECTUS
January, 1985

BOARD OF DIRECTORS

Redley Killion, Chairman	Director Dept. of Resources & Development State of Truk
James Lukan, Vice Chairman	Chief Division of Tourism & Commerce Dept. of Resources & Development State of Yap
Rodney Adelman	Executive Director Economic Development Loan Fund Office of the High Commissioner Trust Territory of the Pacific Is. Saipan
Herman Semes	Manager Mid-Pacific Construction Co. Kolonia, Pohnpei State
Linda Parkinson	Office of the High Commissioner Trust Territory of the Pacific Is. Saipan
Luey Luey	Senator Kosrae State
Peter Sitan	Deputy Director Micronesia Maritime Authority Ponape State

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FEDERATED STATES OF MICRONESIA DEVELOPMENT BANK

PROSPECTUS

The Federated States of Micronesia Development Bank (FSMDB) was chartered by FSM Congress in August 1979 and commenced commercial operations in 1982. It is a Development Finance Institution set up to provide Financial Assistance and related services to the people of the Federated States of Micronesia to accelerate the pace of economic development of the nation.

The FSMDB will participate in lending by granting loans to economic activities at concessional rates. All loans are fully recoverable as per the repayment schedules that will be worked out by the bank and the borrower. Terms will be based on the financial and economic factors constituting the productivity of each project.

All loan applications are required to meet one or more of the following economic development criteria.

1. Creation of new/additional employment
2. Import substitution or export oriented
3. Catering to new facilities and services needed
4. Reduce the cost of consumer goods

The lending program of the bank envisages amongest other things
- to stimulate and increase agricultural production
- to establish new enterprises in commercial fishing and related support industries/activities
- to provide capital for those involved in manufacturing, servicing, transportation and tourism

The FSM Development Bank will in close cooperation with the Departments of Resources and Development and others involved in developmental activities assist in the identification and promotion of most viable investment opportunities currently available. Charting together the economic, technical and financial expertise from local, National and Foreign Sources the Bank will bring into focus the projects that have good chances of economic success and are in the best interest of the Nation.

SECTORS FOR FUNDING

FSMDB will entertain projects under the following sectors for funding.

A. Agriculture
B. Fisheries
C. Manufacturing
D. Real Estate
E. Commercial Activities

APPENDIX 8a

SCOPE OF PROJECTS

1. Agriculture: Lending program is addressed for the development of agriculture and livestock farming in the FSM. Agriculture activities include clearing of land, land preparation, purchase of planting materials, fertilizers, pesticides and labour. Other needs of the projects such as installation of water systems, acquisition of transportation facilities may also be considered. Activities under livestock include:
raising of Piggery, Poultry and Cattle, purchase of stocks, feeds medicines and construction of breeding houses and sheds.

2. Fisheries: Program is designed to assist fishermen already engaged in fishing and those contemplating to enter the industry. Following activities are considered for lending:

Acquisition of boats, engines, fishing equipment and accessories, development of fish ponds, prawn culture, seaweed farming and similar ventures.

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3. Manufacturing: Financing is considered for extractive and conversion of new materials into semifinished or finished products, e.g. sawmill, woodcraft, furniture, concrete products, sand and gravel, footwear, garment, food processing, metal fabrications, etc.

4. Real Estate: Includes loans for construction, expansion and repair of commercial buildings, hotels, apartment houses for rent including acquisition of appliances and furnitures.

5. Commercial Loans: Loans for auto repair shops, restaurants, transportation, trading or marketing and related businesses.

6. Guarantee Loans: The FSMDB is also authorized to guarantee loans that may be granted by other Commercial Banks in the FSM. FSMDB will arrange details with other financial institutions on behalf of the borrower.

AMOUNT OF LOAN

The maximum loan amount for a project shall not exceed $150,000. The amount includes loan guarantee or combination of loan and guarantee to one project.

RATING OF INTEREST AND REPAYMENT

The rate of interest for all loans is 9% per annum. The period of repayment will be determined on the basis of financial capability of the project, the paying capacity of the borrower and the collateral offered. The maximum term granted for repayment will not exceed 25 years. Loans are repayable on a monthly basis. Penalty charge of 1% per month will be levied on late payments on the amount due.

ELIGIBILITY OR BORROWERS

Citizens of Federated States of Micronesia or Trust Territory residing in FSM are eligible to borrow from FSMDB. Applications filed by partnerships, cooperatives or corporations should contain 51% ownership by FSM citizens.

OTHER REQUIREMENTS

A. Equity: Equity means the borrower's share or contribution to the project. It may take the form of cash or kind which shall be invested or used together with the loan fund to implement project operation. Minimum 10% equity is required by FSMDB.

B. Collateral: All loans shall be secured by land titled or untitled including existing improvements or any to be constructed thereon. Assets acquired from loan proceeds such as vehicles, boats, equipment, furniture, machineries are mortgageable. Leasehold interest on land and improvements thereon are also acceptable as collateral.

C. Other Following are general requirements that must be complied with by all loan applicants.

1. Description of the project
2. Financial statement
3. Income and Cash projections
4. Documents covering the collateral

8b

offered and project site
5. Building plan, list of materials, price quotations of assets to be acquired, etc.

A full checklist of requirements is mentioned in the application form.

LOAN DISBURSEMENT PROCEDURES

Since the bank follows supervised scheme of lending the funds are released on drawdown or staggered basis in terms or the purposes stated in the project.

METHOD OF APPLICATION

Detailed information with respect to the lending facilities of the bank will be available from the following:

FSMDB HEADQUARTERS
KOLONIA, PONAPE
FSM 96941 Phone: 840

FSMDB Branch Offices:

YAP	Phone: 2165
TRUK	Phone: 700/761
KOSRAE	Phone: 3070

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PRINCIPAL OFFICERS - HQ

Manny Mori	Acting President
Sam Elwela	Consultant
Leo Carpio	Loan Analyst
Marilyn Johnson	Accountant
Roman Rosokow	Loan Analyst (Developmental)
Jeff Girdner	PCV

FSMDB HEADQUARTERS
P.O. Box M
Kolonia, Pohnpei 96941
Phone: 840

BRANCH OFFICERS

YAP

Loan Officer
P.O. Box 81
Colonia, Yap 96943
Phone: 2165

TRUK

Loan Officer
P.O. Box 786
Moen, Truk 96942
Phone: 760/761

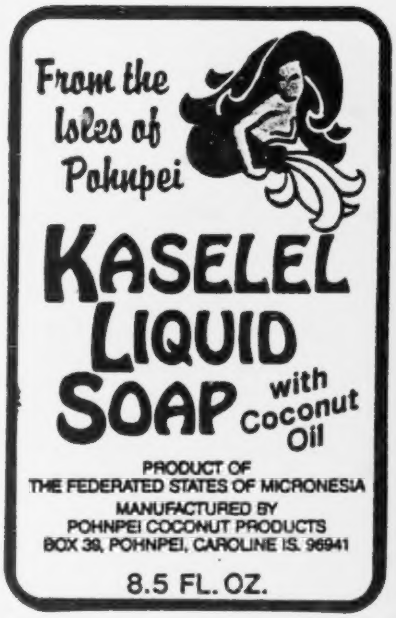
KOSRAE

Loan Officer
P.O. Box 104
Lelu, Kosrae 96944
Phone: 3080

POHNPEI
FSMDB HEADQUARTERS

Loan Officer
P.O. Box M
Kolonia, Pohnpei 96941
Phone: 840

8c



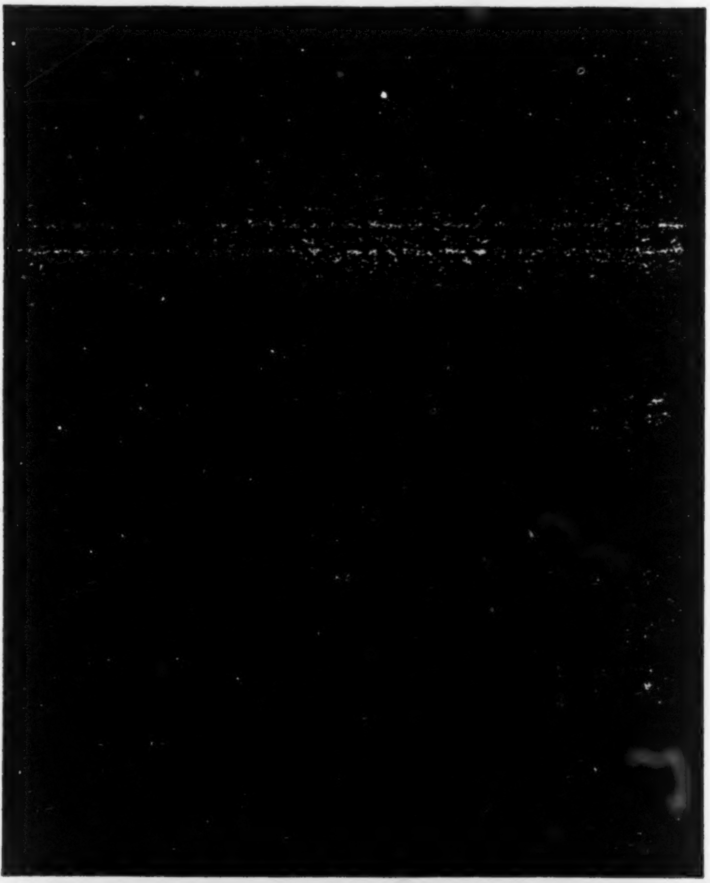
From the Isles of Pohnpei

KASELEL LIQUID SOAP with Coconut Oil

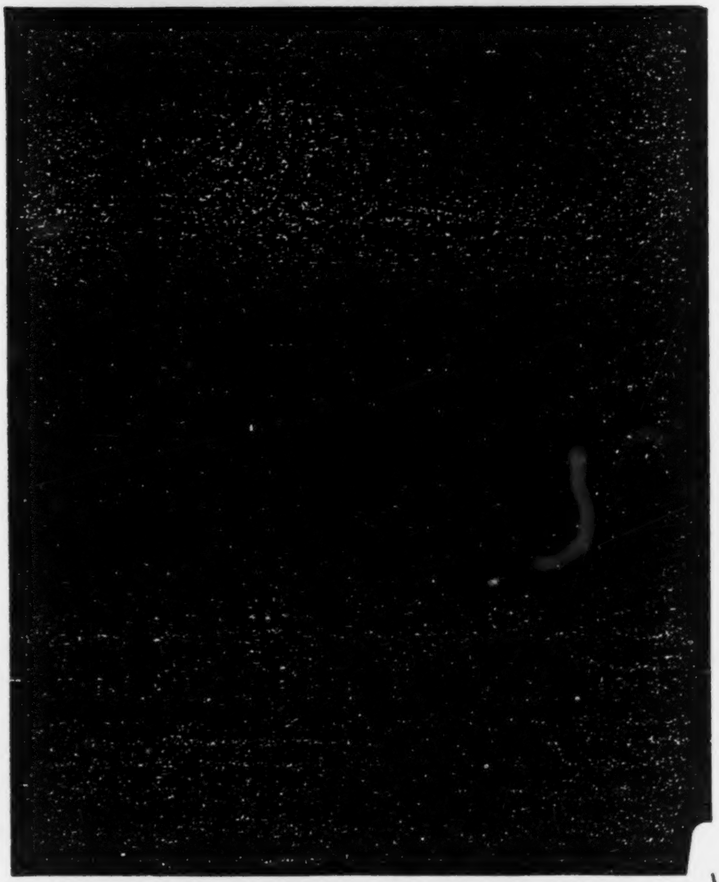
PRODUCT OF
THE FEDERATED STATES OF MICRONESIA
MANUFACTURED BY
POHNPEI COCONUT PRODUCTS
BOX 39, POHNPEI, CAROLINE IS. 96941

8.5 FL. OZ.

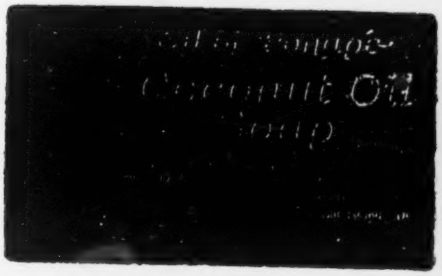
Hnadwashing label



Cooking oil label



Large handwashing label



Bath soap label

FOOTNOTES

1. The author was the manager of the PATS farm for 5 years. During this time he kept detailed records on all aspects of the enterprise, as well as completing economic and agronomic studies on several crops being grown. Since the farm's main purpose is education and demonstration, it is not totally "commmercial" in the true sense of the word, but it is expected to at least break even each year.

2. The author visited major agricultural areas on both Guam and Saipan with local agriculture department personnel in 1981. This comment is made on the basis of that visit, and the fact that in his travels throughout Micronesia, he has not again observed the scale or success of the operations that he saw on Guam and Saipan.

3. The author has extensive experience with herbicides in Pohnpei. This comment is made on quick calculations of the economics of herbicides. Glyphosphate is $119.40/gal. and Paraquat is $67.60/gal. (Brewer Chemical Co., Guam, p.c., Nov. 26, 1986), not including shipping from Guam. Recommended rates are about 1 gallon/acre for each. At PATS, we figure that complete tillage, including two diskings, and bed-making with tractors costs less than $50/acre (including operator, repair, depreciation, interest, and fuel.) While herbicides have additional benefits as leaving mulch on the soil, decreasing erosion, etc., they are relatively capital intensive, and furthermore are not generally available to farmers unless they import them themselves.

4. It seems that the system is rather labor intensive and requires a high management level. Also, there is not much interest in biogas at the farmer level, especially with at least one other source of fuel- kerosene, diesel, gasoline, as well as electricity- cheaply availiable to most farmers. A UN Vetrinarian working on Yap, Dr. Thavalingam (assigned under Sam Falanruw, Dept. of R & D), may have more comments on biogas production, as he has set up a small unit on Yap.

5. In a conversation with Jeff Barcinas of the Guam CES, he mentioned to the author that there was at least one farmer he knew of who was using a 80 HSP, 4 WD tractor.

6. The author did not find an evaluation of the caribao introduction on Palau. He would venture to guess from his own experience on Pohnpei that absence of suitable animal-tillage equipment, lack of a tradition of animal-power amongst Palauans, and labor and maintenance requirements for animal tillage could have been some reasons for the project's failiure. The "ossib", on the other hand, is closer to traditional tools (shells), and most likely, the Palauans had a long history of forced use of the tool on Japanese and Okinawan farms during the Japanese

Administration, as on Pohnpei, where locals provided most of the labor for menial work, ie.- tillage. After many years of using it, and discovering it's superiority to traditional tools, many adapted it.

7. The author personally compiled this data from the records of the Equipment Services Division in July, 1985. This information was later used in the newspaper and on radio to lobby successfully for funding for another bulldozer for the Division of Agriculture. The author personally inspected several of the roads and farms and noticed that very little effort was being made to control erosion. Some roads were made going up very steep slopes, and several fields were plowed and bedded going against the contour. Complaints about this went unheeded. Falanruw (1980) points out her own distress that agricultural land-clearing does not require permits as does other types of clearing. She sited agriculture activities, especially with introduced practices such as total clearing, plowing, planting of annuals, and clean weeding, as possible causes of harmful siltation in stream and marine environments.

8. The author makes this statement on the basis of his own experience. Although data on farm size is rather scarce for Micronesia, Khamoui (1985) reports that 93.5% of all land-holdings on Guam are less than 5 acres. The author has assumed, that on the basis of this report, and further communications with A. Lorens and A. Ansin, Chiefs of their respective Ag. Divisions on Pohnpei and Truk, that most land-holdings in Micronesia are below 5 acres in size. This would be considered small in commercial farming. Relatively high labor costs, based on average salaries and minimum wage rates, are relatively high compared to other countries in the region. The author believes that general high expectations of financial returns to farmers are a product of these high wages (mainly in the public sector) and the generally high prices for produce that have been set through the School Lunch program and other local marketing outlets, when compared to prices in other Pacific nations.

9. The author personally ran this trial and initial results are available from PATS.

10. The author personally saw the rejection forms while he was acting as advisor for the the pepper grower's coop, PPGA. Shipments were rejected because of insect eggs, rodent hairs, and rocks in the pepper sampled, and because of improper labeling (white pepper was labeled black and vice-versa.) These shipments were made by a local businessman/politician, without the knowledge of the government (Veratau, 1985).

11. In the course of this paper, the author received several reports of successful cooperative efforts, especially in Guam and Saipan (Barcinas, Pangelinan, p.c.s, 1985). In 1984-85, at least 7 cooperative-like farmer's organizations were organized on Pohnpei. The groups seem to have been formed for the purpose of

political action, due to the fact that municipal governments on Pohnpei can charter local organizations (non-profit) and then provide funding to them, mainly for secondary road construction. There has been no support given to these groups in terms of cooperative education, management training, or further funding after the roads are built (Lorens, p.c., 1985). The F.S.M. Development Bank, can give loans to these groups, once they are chartered (Mori, p.c., 1986) and at least one group investigated the possibility. Some of these farmer groups have since gone inactive.

12. Special contracts, under which many expatriates have worked on Pohnpei, have been discontinued by Governor Resio Moses for Pohnpei (Veratau, 1985). The general hiring policy now is to consider all Micronesian candidates for jobs first, and expatriates only after no suitable employee can be found locally. Then, most are hired on at local salary, which is much lower that for what most expatriates would care to work for (Lorens, p.c., 1985). For the first time, all the chiefs of Agriculture Divisions in Micronesia are Micronesian citizens: Aijang Paul-Marshalls, Herman Francisco-Palau, Constantine Yinug-Yap, Arthur Ansin-Truk, Adelino Lorens-Pohnpei, and Credence Phillip-Kosrae. Mr. Lorens has informed that it would be nearly impossible to bring in anyone as an employee above his salary, which is $498/biweekly. Even the Land Grant Program has hired only one expatriate agriculturalist, Dr. Reuben Dayrit, and he has been on Pohnpei 20 years.

13. Pohnpei pursued a vigorous homesteading program under Governor Leo Falcam in the early 80's. Saipan leases out land at Kagman Station to farmers (Mark, 1982a). There are probably other programs of which the author is unaware.

14. Many of the agricultural development projects undertaken in Micronesia have involved grants or payments for participation by natives. The Germans paid Ponapeans to plant coconuts, as did the Japanese, who expanded similar programs to other crops. The U.S. tried this with coconut, cocoa, and even pepper when it was first introduced. The practice was finally curtailed by the TTPI government, when it was determined that the grant program was being taken advantage of. Many farmers would plant trees or start up various other enterprises to get the payment, and then never take care of them again. It seems that the "grant" mentality, the idea that money for starting business projects needn't be paid back, is still common among Micronesians, and it has made collection of loans a real problem.

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38. Black pepper intercropped with head cabbage. Soil was prepared using a 7 HSP rototiller. SISC, Pohnpei.

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SUPPLEMENT:

POTENTIAL SPICE, SPECIALTY, AND ESSENTIAL OIL CROPS FOR POHNPEI, F.S.M.

INTRODUCTION:

The development of spice and specialty crops in the U.S.-affiliated islands has been mentioned often, but except for a few isolated introductions and trials, the author is not aware of anything notable to date with the exception of black pepper on Pohnpei, which is well-documented elsewhere. Among the possible spice and other specialty crops that could be grown in the islands, the following should be investigated:

Spices

1. Allspice
2. Cardamom
3. Chili Pepper
4. Cinnamon
5. Cloves
6. Ginger
7. Nutmeg
8. Turmeric
9. Vanilla

Other Specialty Crops

1. Cashew
2. Wild Cinnamon
3. Cocoa
4. Coffee
5. Macadamia
6. Sakau (Kava)
7. Tobacco

Essential oils, another type of specialty crop, will also be dealt with in this paper. Among those with possibilities for the island are:

1. Ambrette
2. Bergamot
3. Citronella
4. Gardenia
5. Lemon Grass
6. Mint
7. Neroli
8. Petit grain
9. Ylang-Ylang
10. Vetivert
11. *Fragraea Sair*, etc.

A. SPICES

1. Allspice (*Pimenta dioica*)

Allspice is an evergreen tree reaching 20 - 30 ft. in height. The spice is the dried, unripe fruit, that combines the flavors of cinnamon, cloves, and nutmeg. It is used in pickles, ketchups, and sausages. Leaf oil is used in soap making and perfume. Jamaica is the chief producer.

It is adapted to humid areas with a rainfall of 80-120"/year and under 1000 ft. elevation. Well-drained limestone soils are most suitable in Jamaica.

The tree is propagated by seed and then transplanted out to the field in the 2-4 leaf stage (10 mos. old) or when it is 10-15 in high. Three seedlings are planted to each place, spaced 24-30 ft. apart and thinned to one plant at first bearing, which is usually at 5-6 years. Maximum yields are realized at 15 years. Yields of 5-50 lbs/tree are common. Allspice must be hand harvested.

Circle-weeding is advised and nitrogenous fertilizer or manures may be beneficial, especially if the tree is being grown for leaf oil.

The price of allspice on the world market is not know by the author.

2. Cardamom (Elettaria cardamomum)

Cardamom is a herbaceous perennial with underground rhizomes. The aerial shoots form clumps up to 3m tall. Leaves may grow to 1m long. The spice is the fruit capsules, which are dried and cured. It is used as flavoring, chewed with betelnut in India, and a volatile oil can be extracted for use in perfumes, liquors, etc. It is native to India and Sri Lanka, and India now produces some 80% of the world supply.

Cardamom grows best under light shade in free-draining soils rich in humus. It is generally planted in rain forest soils cleared of undergrowth and with overhead shade trees thinned. It is reportedly grown under betelnut and coffee in some areas. Most production is in areas above 2,000 ft. high with rainfall of more than 100 inches/year.

There are two varieties, Malabar cardamon, and Sri Lanka cardamon (a wild type).

Cardamom is planted from seeds or rhizomes. Seedling plants or rhizomes are planted at around 2m apart in holes 2' x 2' x 1 1/2' deep, which are filled with top soil and organic manure. Afterwards, care consists of weeding, mulching, removing old stems, and regulating shade. Heavy manuring is beneficial.

Seedling plants bear in 5 years, rhizomes in 3 years. Economic life is 10-15 years. Capsules are picked when nearly ripe, 5 or 6 times/year. Yields of 100 to 280 kg. are obtained. Capsules are dried and cured before selling. Cardamoms were selling for around $3-4/lb. in 1981.

3. Chili Pepper (Capsicum frutescens)

Chili pepper is an annual crop, and varieties are already common in Micronesia. It originated in South and Central America but has been spread throughout the Tropics. India is the biggest exporter, followed by Thailand.

Chili peppers are grown from sea level to 6000 ft. and are generally a rainfed crop, requiring a rainfall of 25-50 in. Too much rainfall is detrimental and leads to poor fruit set and fruit rot. Water-logging causes leaf shedding. Best soils should be light loams rich in lime, but chili pepper can be grown in a variety of soils, as long as they are well-drained.

Production starts about 3 months after planting and the plants bear for 3-6 months or longer, depending on variety. The fruit is picked when red, and then dried. 3000 lbs/acre dried peppers is an estimated yield for Pohnpei (Mott, 1979).

Mott (1979) claims that the market for chili peppers is strong and prices are $0 80-0.90/lb. Hand-harvesting is required at regular intervals of 1-2 weeks. A variety would need to be identified that is resistant to bacterial wilt, a fungus disease common in Micronesia soils. Local resistant varieties could be tried. It can be grown between black pepper or other perenniel crops.

4. Cinnamon (Cinnamomum zeylanicum)

Cinnamon is an evergreen tree that grows 25-40 ft. high. The spice is the dried bark of the young shoots and is a popular flavoring. The tree is native to India and Sri Lanka, the latter still a major producer along with the Seychelles, of high quality cinnamon.

The tree is suited to the hot, humid tropics with rainfall of 80-100 inches/year. The tree prefers sandy soils.

Usually cinnamon is propagated by seed in a nursery. Young seedlings are planted out in the field after 8-9 months, at a spacing of 6-8 ft. between trees. Stems are cut back after 2-3 years and covered by a mound of soil. These coppice and make shoots which are then thinned to leave only 6 per stump. These shoots are allowed to grow for 2 more years, until they are 6-10 ft. high and 1/2-2 inches in diameter. At this time they are cut from the stem, which is again allowed to regenerate.

Shoots are harvested during rain, to facilitate peeling. Leaves and twigs are trimmed off and the bark is removed by making 2 longitudinal cuts, and half the bark is removed as one piece. After fermenting for 24 hours in covered heaps, the epidermis, cork, and green cortex are removed by scraping. On drying, the bark rolls into a quill (or pipe) form. Yield from the first cutting (after 4-5 years) is 50-60 lbs. quills/acre/year, increasing to 100-150 lbs in subsequent cuttings and declining after 10 years.

C. zeylanicum is growing at the Pohnpei State DOA and PATS. A wild relative, C. carolinensis is found throughout the Carolines, and is used locally to make a cinnamon-flavored tea-like drink (Pohnpei: madeu)(Glassman, 1952).

5. Cloves (Eugenia caryophyllus)

The clove is a medium-sized tree growing 30-45 ft. high. The spice is obtained from the dried flower buds. Stems and leaves are used to produce clove oil. The tree is native to the Moluccas and is in the same family, Myrtaceae, as guava and allspice. They are currently produced in Zanzibar and Madagascar. Some are also grown in Brazil. The tree is adapted to the humid tropics, with a rainfall of 50 inches and above. They grow best near the sea at up to 900 ft. elevation. Soils should be well-drained, rich and humus, deep and loamy. In Zanzibar, the best soils are deep, sandy, red, acid loams. Water logging is fatal.

The tree is propagated by seed (germination in 5 weeks) in a nursery for 1 year, or until the plants are 6-10 in. tall. They are planted out at 100-165 trees/ha.

Cloves start flowering after 5-7 years and reach a maximum production at about 20 years. The lifespan of the tree is from 60-100 years.

Flowers are picked off the tree before blooming when just pink, and then the buds are dried. Each tree can yield 3-12 kg./cloves/year.

Husbandry includes circle weeding. Organic manures and nitrogenous fertilizers are suggested.

The clove grows on Pohnpei and reportedly produces fruit in large quantities (Sprout, 1968). Mott (1979) claims they grow well in Indonesia, alongside pepper plantations, with similar soil requirements to pepper. He claims it is more profitable than pepper in Indonesia. He recommended 5 acres to be planted on Pohnpei. A drawback may be that cloves are labor intensive and require hand-picking frequently. Market price in 1979 was $3.25/lb.

The author does not know of any trees in the islands at this time, but other Eugenia ssp. such as E. jambos and E. mallaccensis grow well on Pohnpei.

6. Ginger (Zingiber officinale)

Ginger is a perennial herb growing up to 3 ft. tall. The spice is the rhizomes, fresh or dry, which are short, branching, and scaly. It originated in tropical Asia. China, India, and Taiwan are major producers, as are Nigeria, Jamaica, and Sierra Leone. Cultivation is also practiced in Fiji, Tonga, Australia, and Hawaii in the Pacific.

Ginger is well-adapted to the humid tropics with at least 60 inches rain/year and can be grown from sea level to 4500 ft. Soils should be loamy, rich in humus, and well-drained.

It is planted from rhizomes 1-2 inches long at 20 x 10 inches between plants. Lime should be applied. The crop is harvested after 6-10 months, after leaves start to turn yellow and wilt. Yields vary greatly, but with proper cultural practices, 20-30 tons/ha green ginger can be obtained. Mott (1979) estimates 3-4000 lbs dry ginger/acre for Pohnpei.

Mott (1979) estimated prices to be from $0.70-0.85/lb for dried ginger. He also states that there is a good market for ginger preserved in brine in Japan. Ginger has been tried on Pohnpei (Mott, 1979, Lorens. p.c., 1985) but without much success. Mott cites lack of disease-free stock, lack of suitable varieties, and high rainfall as possible problems. He adds the best time to plant on Pohnpei is April-May. Ginger would make an excellent intercrop with pepper and the author is experimenting with this. The author observed small quantities of ginger being commercially produced for the local market at Ohwa Mission Farm on Pohnpei.

7. Nutmeg (Myristica fragrans)

Nutmeg is an evergreen tree that grows to 30-45 ft. with a short trunk and spreading branches. Male and female flowers occur on different trees. The spices are the dried meat of the seed, known as nutmeg, and the scarlet aril surrounding the seed, known as mace. The tree originated in the Moluccas, and Indonesia is still a major producer, along with Grenada in the Carribean.

The nutmeg tree prefers a warm, moist climate with 60-100 inches rainfall/year. It grows best in areas protected from the wind and near the sea. Soils should be deep, well-drained loams.

Nutmeg is planted from seed, which germinates after 4-6 weeks. Seeds soon lose their viability and should be planted soon after collecting. They have been successfully propagated at PATS and the Ag. Station in Kolonia. When seedlings are 6 inches high (after 6 months) they are planted to the field, 3 trees to a point, about 27 ft. apart. Two trees are removed at the time of flowering (3-5 years) to give 80% female trees. Bearing starts in 5-7 years, and starts to decline at 15-20 years, with production continuing up to 50 years. Yields of 75 kg. dried mace/Ha and 500 kg. dried nutmeg/Ha. may be expected.

Six nutmegs are growing at the Ag. Station, reportedly introduced by M.N. Sprout in the 60's while he was Chief (Hadley, p.c., 1985). The author has planted about 30 nutmegs on his farm and has observed nutmeg planted on two other person's farms in Pohnpei. One farmer in Kitti claims he has planted more than 200 trees. All these plantings are young-less than 2-3 years old. Another tree in the same family, Myristica hypargyraea, (Pohnpeian: Kararah), grows wild in the Pohnpei rain forest (Glassman, 1952).

8. Turmeric (Curcuma domestica)

Turmeric is similar to ginger and grows 3-4 feet tall. A bright orange spice, used for dye, cosmetics, and flavoring, is obtained from the underground rhizomes. It is believed to have originated in southern or south-east Asia, and India is the largest grower.

Adaotation of the plant is much the same as ginger. It is planted by rhizomes. Spacing and fertilization are also similar to ginger. The plant is harvested after 9-10 months when leaves become yellow. Yields are reportedly in the area of 13,000-25,000 kg. of green turmeric/Ha which yields 19-25% of the dry product.

In Pohnpei, turmeric is common plant used mainly for medicine and flavoring, and the leaves are used for covering material. Glassman (1952) lists at least 5 varieties of C. domestica on Pohnpei. 1981 prices were about .29-.37/lb for dried turmeric.

9. Vanilla (Vanilla fragrans)

Vanilla is a climbing vine-like perennial related to orchids, growing up to 15 ft. tall. The spice is the fully mature seeds, which are macerated in alcohol to get Vanilla extract. The plant is indigenous to Central America and Mexico, growing as a wild climber in the jungle. The Malagasy Republic is the largest producer, and it is grown in the French Pacific Islands.

Vanilla is adapted to the humid tropics with rainfall of 80 inches or more and up to 600 ft. elevation. It thrives in well drained soils rich in organic matter.

Vanilla is propagated by cuttings 30-40 inches long and planted at a spacing of 3' x 6' in the field. The cuttings are planted on stakes, and as the plant needs partial shade, living trees are often used, including _Gliricidia sepium_ and _Erythrina ssp._ Mulching is beneficial.

Vanilla beans are produced from the third year on, with maximum production at 7-9 years. Hand pollination is practiced for optimum yields. The pods are harvested 4-7 months after pollination, when they turn yellow. . A brief dry period is needed during fruit ripening. Nitrogenous fertilizers are beneficial. Beans are cured by successive periods of drying and sweating. Yields of about 120 kg. of dried beans are reported.

Vanilla was introduced to Pohnpei by Japanese and later by M.N. Sprout (Sprout, 1958), but it was never tried commercially (Hadley, p.c., 1985).

B. SPECIALTY CROPS

1. Cashew (_Anacardium occidentale_)

Cashew is a spreading evergreen tree growing 21-40 ft. tall. The seeds are the source of cashew nuts, a popular confectionary and dessert nut. Cashew is a native of tropical America and the West Indies. Major producers are India, Mozambique, and Tanzania.

The cashew is hardy and drouth-resistant. It grows well in most tropical soils and climates up to 4000 ft. elevation and 20-150 in/year rainfall. It grows best on sandy soils.

Seeds are sown in containers or directly in the field, 3 seeds/hole, at 30' x 30' spacing. Pruning is necessary to shape the tree for the first 3 years. Bearing starts at 3 years, maximum yield at 10 years, and lifespan exceeds 20 years.

Mature nuts are picked, dried for 2-3 days, split, dried and roasted. Yields are reported to be 80-200 kg./Ha yearly.

Out of an introduction of cashew the author carried out in 1982, one tree is still alive and is bearing at PATS in Pohnpei. Mango is in the same family (Anacardiaceae) and is widespread in Micronesia and the Pacific.

2. Wild Cinnamon (_Cinnamomum carolinensis_)

C. carolinensis (Pohnpei: madeu) is closely related to _C. zeylanicum_, and grows wild in the rainforests of Pohnpei (Glassman, 1952). Natives use the bark as medicine and also to make a delightful cinnamon flavored tea-like beverage that is drank cold or hot. The author tried growing the tree from seed and had some success. It seems the tree prefers shade in it's early growth. It is possible that the tree could be grown like C. zeylanicum, and shoots harvested for greater production. Presently natives working in the jungle cut patches of bark off large trees and dry them for later medicinal or beverage use.

The bark can be stored and may have a possible market, esp. to tourists. Ponnpeians are already familiar with the tree. No further information has been found by the author.

3. Cocoa (Theobroma cacao)

Cocoa is a small tree reaching about 30 ft. high, which is pruned to a much lower height under cultivation. The tree prefers shade in early growth. The beans, from which cocoa is made, are produced on the stems. It is believed to have originated in tropical South America, and the main producing areas are Central America, Brazil, and West Africa. It is also being grown in New Guinea, Solomons and Western Samoa.

The cocoa tree prefers 4-8 inches of rain/month and is best grown in fertile, well-drained soils with pH above 6.0.

It is propagated by seed in nurseries. Seed is viable for only a few days and must be planted immediately. Vegetative propagation by cuttings is practiced in some areas. Trees are planted out to 9-12 feet apart and bananas are planted in between as temporary shade. It grows well between coconuts. Weeds should be controlled by herbicide or slashing as cultivation destroys the shallow feeder roots. Pruning is practiced to give 3 or 4 strong, spreading side branches. The trees starts to flower at about 2 years but is not usually harvested until the 3rd year.

Harvesting is practiced year around when the pods are yellow. The pods are split, beans removed, and then fermented 3 times for 48 hours each, and then dried in the sun.

There are 3 major groups of cocoa: Criollo, Forastero, and Trinitario. December-January are the harvest months for fruiting in Micronesia. Cacao was introduced to Micronesia by the TTPI government in the 1950's, especially on Ponnpei and Truk. Plantings were small and scattered and several problems were encountered - among them rats, a canker disease, lack of technical support, and finally a world price drop in the 1960's. By 1971, the TTPI unofficially declared the project a failure (Soucie, 1972). Although cocoa prices have risen, the author feels it is doubtful whether any farmers would try it again.

4. Coffee (Coffea ssp.)

Coffee is a small tree that can reach 30 ft. in the wild, but is pruned to a smaller size under cultivation. Coffee berries are produced once/year. There are three species - C. arabica, which produces the finest quality coffee, C. canephora (Robusta), a medium quality coffee, and C. liberica, which has a bitter flavor and is generally used as a filler. All tree Coffea ssp. originated in Africa. Brazil and Colombia dominate the market but it is also produced by several other countries, especially in

Central America and Africa.

C. arabica prefers cooler climates (72 F optimum) and an elevation above 5000 ft. *C. canephora* is better adapted to lowlands with temperature of 77-82 F. *C. liberica* is the most hardy and can be grown in the equatorial lowlands. All require about 70-120 inches/year rainfall. Soils should be deep, fertile, and well-drained, with a pH of 5.5-70.

Coffee is generally planted by seed in the nursery. Plants are transplanted to the field after 5 months at 7 feet spacing for *C. arabica* and 9 feet for the other species. Fertilization should be practiced 4-6 times/year. Coffee must be pruned for high yields, generally soon after harvest each year. Weed control is by hand or herbicides. Trees come into bearing after 3-4 years and full production by 6-8 years. Yields are 400-900 lbs/A under normal care.

Berries are hand-picked, the pulp removed, and then fermented to remove the mucilage from the seed. Seeds are then washed and sun-dried. After drying, the brittle skin around the seed is removed.

Coffee has been introduced to Pohnpei by both the Japanese and Americans (Hadley. p.c., 1985) Ag. Station records show that the following varieties of *C. arabica* have been introduced to Pohnpei: Yellow Bourbon, Bourbon, Kona typica, Yellow Caturra, and Red Caturra. Presently, only Kona is still growing, which the author is propagating by seed. There is a Japanese plantation in Sokehs where several trees are still growing, some 20-30 ft. high. The farmer is replanting this variety from wild seedlings with the assistance of the Ag. Station. (Veratau, p.c., 1985). Morea Veratau has mentioned that he wrote to Costa Rica for new varieties for Pohnpei climate.

At least one insect pest, the Coffee Bean Borer (*Hypothenemus (Stephanoides) hampei* (Ferr.)), along with the Green Coffee Scale (*Coccus viridus*) and *Hemleia vastatrex* (leaf rust fungus) have been recorded in Micronesia (O'Connor, 1969). Rubiaceae, the coffee family, has may members in Pohnpei and it is possible that these pests and diseases are still thriving in the wild. This could preclude any large development of coffee in the area. The emphasis on coffee at the Pohnpei DOA is mainly as an import substitution crop. Although no records are available for coffee imports into Pohnpei, they are thought to be substantial as coffee is a common beverage among Pohnpeians (Lorens, p.c., 1985).

5. Macadamia (*Macadamia ternifolia*)

Macadamia is a small tree growing to 45 feet tall. Fruits have a fleshy husk and a single round seed with a hard, brown shell, which is a popular desert nut and confection. Macadamia is native to eastern Australia, and is produced commercially mainly in Hawaii.

Macadamia is better suited to sub-tropical regions but can grown in the humid tropics. It needs much moisture and yields are poor in areas with a prolonged dry season, unless irrigation is practiced. It does best on deep, friable, fertile loams with a pH of 6-6.5.

Macadamia is propagated by seed, then selected varieties are grafted or budded onto rootstocks at 12-18 months. Lime should be added to acid soils. Trees are planted out to the field at 27-30 feet spacing. Mulching and fertilization are practiced. Mature nuts are produced year-round and are collected from the ground at 1-3 week intervals, dehusked, and dried on racks for 3 weeks. Yields start about 3 years after transplanting and continue to increase. 10 year old trees yield 10-18 kg. nuts/tree/year and yields reach maximum at about 15 years old.

The tree has been introduced to Pohnpei Ag. Station, and reportedly, single trees were planted in other areas. The author heard from one farmer that they chopped down their tree because of it's sharp leaves which it dropped periodically, which made it hard to walk in the vicinity of the tree (many older Pohnpeians go barefoot.) The author is growing 3 trees from seeds he got from Hawaii.

6. Kava (Piper methysticum)

Kava (Pohnpei: sakau) is a bushy shrub up to 9 feet tall in the pepper (Piperaceae) family. A beverage is made of the pulped roots and lower stems, squeezed through a bast of fibers from the tree Hibiscus tiliaceus. It is a common plant in Polynesia and is widely cultivated on Pohnpei.

Kava is generally planted by stem cuttings on partially cleared jungle areas. It is commercially planted in Fiji at spacing of 4-5 feet. The plant can be fertilized, although it is not practiced on Pohnpei. The plant is harvested after 2-3 years or longer. Yield of about 2.5 tons/Ha is reported from Fiji (P.Sivan, p.c., 1985). There is a growing interest in producing kava since a Japanese firm, Haotoka, Ltd., expressed interest in developing a novelty beverage from the plant for the Japanese market. Because of concern of endangering watershed areas on Pohnpei by increasing traditional cultivation practices, PATS has embarked on a 3 year trial in conjunction with the Pohnpei DOA to commercially produce kava using Fijian recommendations. (Raynor, 1985).

7. Tobacco (Nicotiana tabacum)

Tobacco is a stout perennial herb, 3-7 feet high, usually grown as an annual. The leaves are cured, dried, and used for smoking, chewing, and snuffing. Tobacco originated in the Americas and has since been spread throughout the world. The U.S. is the largest producer, followed by China and India.

Tobacco is grown from seed and transplanted to the field at 2' x 3' spacing after 40-60 days. Weeding and fertilization are practiced. The inflorescense and top-most leaves are broken off at flowering to improve yield and quality 60-70 days after transplanting. The whole stem is harvested after a further 40-55 days, leaves allowed to wilt, and then hung in a curing shed. Leaves can also be harvested at weekly intervals. Yields of from 400-2000 lbs/A have been recorded.

Pohnpeians have grown tobacco for many years. In the 1950's, some large scale planting was done for export to Japan. Japan was disappointed with the quality, as the leaves had much insect damage. They offered to buy it as filler at a very low price, which was not economical, and the tobacco rotted at the dock. (Soucie, 1972.)

The author is currently experimenting with some "Burley" tobacco plants to see how well they do with proper agronomic practices.

8. Other Specialty Crops

Betel nut (Areca catechu) and Betel leaf (Piper betle) plantings are increasing as betel nut chewing becomes more widespread in Micronesia. There may be commercial opportunities for further plantings. Derris (Derris elliptica) grows wild on Pohnpei and is used to stun and kill fish (Glassman, 1952). The roots contain rotenoids which could be developed into an insecticide. Other plants may have development possibilities.

Spice and specialty crops offer for the most part, high returns on small plantings, if properly cultivated. There are numerous problems, though, with these types of crops when introduced to Pohnpei, among them:

1) Perennial Nature: Most are perennials with a period of 3-6 years before first harvest. However, during this time before harvest, the crops need continual care- weeding, fertilizing, and in some cases, pruning. Also capital must be expended to establish the planting, which won't be recovered for several years.

2) Fertilizer: Regular fertilizing is the key to good yields on most crops. Mott (1979) noted that lack of fertilization was one of the major problems in pepper production on Pohnpei.

3) Harvest: Many crops produce year-round and need to be continually harvested to get economic yields. Others need harvesting all at one time, making large demands on labor. Pohnpeians have practiced harvesting only when there is an immediate need for cash (like the practice on copra production) and labor shortages due to the "family" nature of most farms could lead to large portions of the crop being left unharvested.

4) Extension Services: In introducing a new crop and improved husbandry practices to farmers, a well-planned and executed extension program is needed. It is doubtful, looking at the rather sporadic services offered even on black pepper, whether the present extension system can handle this task. Historically, technical services to farmers has been a weak link in crop introduction and commercialization programs on Pohnpei (Soucie, 1971).

5) Drying: Many crops require sun-drying. With high rainfall on Pohnpei and relatively few sunny days, this could be a constraint.

6) Quality Control: Production of any spice or specialty crop, especially for export, demands rigid quality standards, from grading of materials brought in by farmers, to final inspection after processing. Pepper has already suffered due to insufficient quality control (Lorens, p.c., 1985). Due to small production, exports or on-island sales will most likely be aimed at the gourmet or specialty market, so quality must be better than that of other producing areas.

Advantages of spice and specialty crops are:

1) High price/lb., making small plantings economical.

2) Most can be grown and processed using simple technologies.

3) Processed product is relatively imperishable so they can be easily stored and shipped via existing transportation facilities and services.

4) Several of the crops mentioned can be intercropped with vegetables, bananas or other commodities produced on Pohnpei. Others can be used as intercrops between coconuts, black pepper, etc., to make use of space while the crops are not yet producing.

5) Climate and soils on Pohnpei are ideal or well-suited to the crops mentioned.

6) At present, there are no serious pests or diseases of these crops known, except for coffee and tobacco, which are elaborated on in the text.

If spice and specialty crops are being contemplated for possible introduction, the following considerations should be taken into account:

1) Varieties - all crop species differ in characteristics, such as hardiness, vigor and yield. Efforts must be made, probably through the government, to locate and import only the best varieties to Pohnpei. After introduction, variety trials will need to be carried out to further test adaptation and yield, preferably before release to farmers.

2) Expertise - success with these crops will depend on the technical expertise of the agency or individual who introduces the crop. In some cases, outside experts may have to be contracted during initial stages of projects to facilitate determination of husbandry, harvest, and processing requirements.

3) Processing - efforts must be made to acquire suitable processing facilities or methods to ensure high quality in the finished product.

4) Economics - after reliable estimates of yield are made, cost of production in relation to selling price must be made to determine whether returns to farmer and processor are enough to

ensure continued and increasing production.

5) Markets - although markets probably exist for all the crops mentioned, serious efforts must be made to assure that production will be sold at a reasonable price. Pepper has continually suffered because of unstable production and sporadic marketing efforts (Veratau, p.c., 1985.)

C. ESSENTIAL OILS

Along with edible and industrial oils, plants produce a variety of essential oils. Essential oils are usually aromatic and volatile. Usually they are found in the vegetable parts of plants, and often in flowers. Essential oils contain complex mixtures of alcohols, esters, aldehydes, ketones and terpenes. In the plant they generally serve as insect attractants or repellants.

Essential oils are removed from the plant in three ways - distillation, solvent extraction, and expression.

1. **Distillation:** This method is widely used for essential oils which are decomposed by steam temperatures. Plant parts are chopped and placed in a steam still, where steam removes the essential oil in vapor form. Vapors and steam are condensed through water-cooled coils. In a receiver the aromatic oil floats on water and can be removed. Yields are generally 1% or less by weight.

2. **Solvent Extraction:** This method is used on less stable oils. The most commonly used solvent is petroleum ether, but chloroform, ether, and alcohol are also used. The solvent percolates through the plant material, and removes essential oils and many contaminants. The latter are removed in various ways depending on their nature. Yields of essential oils are usually higher than with steam distillation.

3. **Expression:** This method involves high pressures used to remove oils from plant parts.

Essential oils generally have a high price/lb. compared to other oils and this makes them an attractive commercial possibility. The following are essential oils that could be produced on Pohnpei:

1. Ambrette

Ambrette is extracted from the seed of the plant Hibiscus abelmoschus, probably native to India, which grows wild on Ponnpei (Glassman, 1952). Reportedly, production is limited to southern France. It is extracted by volatile solvents. Ambrette is used in fine perfumes.

2. Bergamot

Bergamot is extracted by distillation of the fruit rind of *Citrus aurantium*, or sour orange, which has been introduced to PATS. It is produced in Southern Italy by expression of the fruit rind and is used in colognes. It is reported that the *C. aurantium* used may be a subspecies - bergamia (Risso. & Poit.) Weight and Arn., and thus the species on Pohnpei might not be useable.

3. Citronella

Citronella oil is extracted from the leaves of the grass *Cymbopogon nardus*, which is planted by rhizomes, native to Sri Lanka. It extracted by distillation. Citronella is used in cheap perfumes, and has been suggested for use as a scent in laundry soap produced by Ponape Coconut Products. (Sam, p.c., 1986). The oil has a citrus - like scent. Main production is reported to be in Java and Central America, particularly Guatemala. Yields in Java are reportedly 45-80 kg. of oil/Ha.

4. Gardenia (Gardenia ssp)

Gardenia oil is extracted from the flower of the herb. *Gardenia*, of which several species are known. At least one species, *Gardenia jasminoides*, is grown on Pohnpei as an ornamental (Glassman, 1952). The plant is a native of SE. Asia, and production is practiced on Reunion Island in the Indian Ocean. Volatile solvents are used in extraction and the oil is used in perfumes.

5. Lemon Grass

Lemon grass oil, an a similar but inferior oil to Citronella, is extracted by distillation from the foliage of the grass *Cymbopogon citratus*. The chief production areas are the Far East, C. America, and Florida. Lemon grass is used in the manufacture of synthetic perfumes and soap, and has been proposed for use as a scent in laundry soap at PCP. (Sam, p.c., 1985) Lemon grass is growing at PATS. It is widely adapted to humid tropic climates and soils. Yield of oil is 40-110 kg./Ha.

6. Neroli

Neroli is extracted by distillation from the blossoms of *C. aurantium* and *C. sinensis*, the sweet orange. Main production is in the area of Provence, France. It is used in synthetic perfumes and colognes.

7. Mint

Two species, *M. piperita* (peppermint) and *M. spicata* (spearmint), though from temperate regions, have been grown in the tropics. Both of these produce commercial essential oils by steam distillation and are used widely as flavorings.

8. Petitgrain

Petitgrain is extracted from the foliage of *C. aurantium* and *C. sinensis* by distillation. Main sources of production are the Mediterranean and Paraguay. The oil is used in soap and colognes.

9. Ylang-Ylang Oil

Ylang-ylang oil is extracted by distillation from the flowers of the tree *Cananga odorata*, which is native to S.E. Asia, and is a common tree in the wild on Pohnpei (Pohnpei: Sair en wai). The bulk of the world's supply comes from Reunion Island. The tree is evergreen, growing 3-30 m high, with fragrant flowers. Trees are topped at 9-10 feet to facilitate harvesting.

Flowers are harvested in the early morning and distilled the same day. The tree starts producing at 1-2 years and flower yields increase with time. 10 year old trees have produced 9-10 kg. oil/Ha.

Ponape Coconut Products(PCP) has done extensive research on Ylang-Ylang and oil samples distilled from local trees by a U.N. contracted chemist, Mr. Puvaneswaran, have received favorable response locally and abroad (Sam, 1985). An effort is underway to go ahead with production and funding has been granted to purchase the distillation apparatus from the Philippines (Sam, 1985). The main use of the oil will be to substitute for imported perfume in PCP products. Excess production will be exported (Sam, p.c. By producing Ylang-ylang oil and substituting it for imported perfumes in their products, PCP estimates an $8000 yearly savings.

The author is serving as agronomist to the project and has supervised a planting of 110 trees at PATS to ascertain growth characteristics and proper husbandry for the Ylang-ylang tree. The author is also assisting with extension efforts to local farmers.

10. Vetivert

Vetivert is extracted by distillation from the roots of the grass, *Vetiveria zizanioides*, native to India and Sri Lanka. It is grown widely throughout the tropics and subtropics, but is not recorded in Pohnpei. Haiti, Reunion, and India are the main producers. 40-100 kg./Ha. of oil have been recorded. The oil is used in fine perfumes.

11. Other

Mr. Puvaneswaram has suggested that essential oil may be extracted from the following shrub, *Fragraea sair*, (Pohnpei: Sair en Pohnpei) which is common on Pohnpei. The flower has an attractive, pleasant scent. Other local flowers may be tried in the future. (Sam, p.c., 1985.)

Since essential oil production is dependent on extraction technology being available for distillation, solvent extraction, or expression, lack of this equipment is a major constraint in commercial development. The extraction technology also demands the service of a chemist, or suitably trained individual to carry out initial development work. PCP has been fortunate to have the service of Mr. Puvaneswaram for 3 years from the F.S.M. National Government (Sam, 1985).

Much preparatory work should be done before going ahead with an essential oil project, especially since a relatively large investment is involved (Catalino Sam, p.c., 1985) estimated that the distillation equipment for ylang-ylang alone would cost $20,000) Besides initial trials in distillation and quality analysis, agronomy of the crop in question and economics of production need to be considered. The author is consulting agronomist on the PCP Ylang-ylang project, and has found it very difficult to find information on essential oil crops, perhaps because producing areas do not wish to encourage competition. One of the most complete works the author has found on essential oils is the six volume set "The Essential Oils" by E. Guenther, Vam Nostrand Co., New York, N.Y., 1948-49.

Many of the essential oil crops have particular reguirements, especially in harvesting and handling, and a well-planned program of transportation (for pickup and delivery to the place of extraction), quality control (both in harvested material and the extraction process), and general extension work with farmers must be worked out, especially with new crops with which they are not yet familiar.

Summary

So far, there is no miracle crop for future commercial agriculture development on Pohnpei. Spice, specialty, and essential oil crops can, however, be valuable components of an agricultural development plan for the island, if proper planning, variety selection, extension, quality control, and marketing efforts are made. A well-planned development program, perhaps of a mixture of spice, specialty, and essential oil crops, using intercropping, relay cropping, and agroforestry techniques (even integrating desired crops into the traditional agricultural system) will ensure success.

About the Author:

William Raynor is currently the Chairman of the PATS Agriculture Department on Ponape, in which capacity he has had the opportunity to work with or observe many of the crops mentioned in this paper. He also serves as a consultant to the Ylang-ylang project at PCP, and has initrated trials and/or planting of ylang ylang, sakau (kava), coffee, nutmeg, cashew, macadamia, and ginger on Pohnpei. He is manager and part-owner of Senyavin Islands Spice Co., a small company dedicated to introducing and developing spice and specialty crops on Pohnpei, which is also working with black pepper.

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Note: Except where otherwise indicated, all agronomic recommendations, crop information, and production estimates in this paper are from Purseglove's two books and William and Chew's book.

Background Paper No. 3

ROLE OF SMALLHOLDERS IN AGRICULTURAL DEVELOPMENT IN THE U.S.-AFFILIATED PACIFIC ISLANDS

by

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Abstract

Despite the many factors which constrain growth in farm production, there is potential for achieving sustained agricultural development in the Pacific Territories. Government commitment to a smallholder development strategy, as opposed to large-scale, corporate farming is judged most likely to succeed in attaining a sustained growth in agriculture sector production and income. The distinguishing characteristic of the smallholder is the use of family (or clan) owned land and predominantly family labor in farming. Types of smallholder farming in the territories include, subsistence, semicommercial, and commercial. Subsistence farming is predominant in the Marshall Islands, Federated States, Palau, and American Samoa. In Guam and the Northern Marianas, semicommercial and commercial smallholder farming accounts for the majority of total farm production. Value of marketed agricultural production is very small in relation to total domestic production (gross domestic product) in every territory. Major constraints to agricultural growth include limited arable land, fragile soils, land tenure systems characterized by small parcels under extended family control, availability of high paying government jobs, lack of transport and irrigation infrastructure, lack of high productivity farming technology, and small insular markets. Opportunities for agricultural growth include large food imports, part of which could be produced locally; availability of high productivity technology which could be adapted to territorial conditions; unexploited markets represented by USDA school lunch and food stamp programs, and tourism and military bases in some territories; and potential for intraregional and external commodity exports. The smallholder development strategy entails strengthening domestic markets for local commodities, development and dissemination of high productivity technology, providing critical infrastructure, and above all--government commitment to a comprehensive, sustained development program. Choice of the smallholder strategy is based on the larger benefits, greater likelihood of success, and less risk of adverse social and ecological effects compared with a policy of supporting large-scale, corporate farming.

INTRODUCTION

All the U.S.-Affiliated Pacific Islands have adopted the long-term goal of economic self-reliance. These islands are now highly dependent on U.S. assistance and recognize that development of primary industries must occur if their long-term goal of self-reliance is to be achieved. A basic premise of this paper is that agriculture potentially could become a significant primary industry; and further, that a smallholder development strategy is most likely to succeed in achieving agriculture's potential. A strong commitment on the part of government will be needed to overcome the many constraints to agricultural development, and achieve sustained growth in farm production and income. The Pacific Islands cannot be expected to become self-sufficient in food production, but a long-term goal of full utilization of those lands best suited to crop production would be appropriate.

OVERVIEW OF THE PACIFIC ISLANDS

Political Status

The U.S.-Affiliated Pacific Islands include American Samoa, Guam, Commonwealth of the Northern Marianas (CNMI), Republic of the Marshall Islands, Federated States of Micronesia (FSM), and the Republic of Belau (Palau). A. Samoa and Guam are U.S. territories, and the CNMI, while legally still a part of the United Nations mandated Trust Territory of the Pacific Islands, has opted for U.S. Commonwealth status, which will be effective upon U.N. termination of the mandated trusteeship. Republic of the Marshall Islands, FSM, and Republic of Belau, comprising the balance of the Trust Territory, have opted for free association status, which makes the U.S. responsible for defense and gives autonomy to each of these governments in domestic and external affairs. Free association status has been detailed in a Compact of Free Association, which when approved by all parties to the agreement, and the UN, will become legally effective.

In referring to the island areas, the following terms will be used: Pacific Islands or territories, to refer collectively to all six areas; Marianas to refer to both Guam and CNMI; and Compact States, to collectively refer to Republic of the Marshalls, FSM, and the Republic of Belau.

Geography and Population

American Samoa--Situated in the South Pacific, about 2,300 miles southwest of Hawaii, A. Samoa is comprised of five volcanic islands and two coral atoll islands, altogether encompassing 76.2 square miles. Tutuila, the largest island accounts for about 70% of the land area and includes the principal village, Pago Pago, the capital. Population of A. Samoa was estimated to be 34,300 in 1983. More than 90% of the population lives in Tutuila (Soil Conservation Service (SCS), 1984; and Office of Economic Development and Planning, 1982).

Guam--Guam is located about 1,500 miles south-southeast of Tokyo, and 3,700 miles west-southwest of Honolulu. The largest and southernmost island in the Marianas Archipelago (also largest island in Micronesia), Guam is a volcanic (high) island with a total land area of 209 square miles. The capital and main urban area is Agana. In 1983 Guam's population wa estimated to be 113,200 (Economic Research Center, 1984).

CNMI--The Northern Marianas Islands consist of 16 volcanic islands with a total land area of about 185 square miles. Rota, Tinian, and Saipan are the three main islands, which together comprise two-thirds of the land area. About 85% of the total population (19,600) lives on Saipan. Situated a short distance to the northeast of Guam, Saipan is about 3,300 miles from Honolulu.

Marshalls--The Marshalls are comprised of two almost parallel chain-like formations of 31 atolls, containing about 70 square miles of land area. Majuro Atoll is site of the capital, which includes about 13,000 residents, 37% of the population of about 34,900. Kwajalein Atoll, site of a U.S. missile testing base, has a population of about 7,500. Majuro is located about 2,100 miles southwest of Honolulu. The atolls range from 4 to 14 degrees above the equator (National Planning Committee, 1984).

Federated States of Micronesia--The FSM is comprised of four constituent states, Kosrae, Ponape, Truk, and Yap, which cover the middle part of the Caroline Archipelago. Each state encompasses a group of islands. Kosrae has total land area of 42 square miles, essentially all on the main volcanic Island of Kosrae. Kosrae's population is about 6,300. Ponape includes the volcanic Ponape Island (129 square miles), the third largest island in Micronesia, and six inhabited atolls located from 80 to over 400 miles distance from the main island. Population of Ponape State is 26,900, and the capital city, Kolonia, in Ponape Island includes about 25% of the state population. Kolonia is also capital of the FSM. Truk State consists of 15 island groups, the largest being Truk proper (a group of 14 volcanic islands). Total land area of Truk State is about 49 square miles, about 75% in Truk proper. Population of Truk State is 44,600, and the capital at Moen Island, includes about 13,800 residents. The western most state is Yap, which consists of 4 high volcanic islands (Yap proper) and numerous coral atolls and islands scattered over hundreds of miles. Yap proper encompasses about 39 square miles of the total 46 square miles in the state. Population of Yap State is 10,600, with some 6,700 living on Yap Island (State Department, 1984; and Carter, 1984).

Palau--The Republic of Belau includes the western portion of the Caroline Islands, just north of the equator and about 200 miles east of the Philippine Islands. Only 8 of over 200 islands are inhabited. Principal islands include the volcanic islands of Babelthuap and Koror, the capital. Babelthuap is the second largest island in Micronesia with a land area of about 153 square miles, more than 80% of Palau's total area of 178 square miles. Total population of Palau is about 13,000, of which some 7,600 live in Koror (State Department, 1984; and Carter, 1984).

STATUS OF AGRICULTURE

Principal Commodities

In general the diets of Pacific Islanders consist mainly of starchy foods, probably a reflection of the kinds of crops which have been adapted to the local environments. The principal commodities produced in A. Samoa and Micronesia are listed in Table A. In most of the territories taro, coconut, banana, and breadfruit are grown in large quantities--primarily for home consumption. In A. Samoa and the Compact States, the coconut is used for food, drink, and for making tools and utensils important in the household. In areas such as Guam and CNMI, where western and Japanese influence has been greatest, vegetables have become an important part of the diet.

Pork and chicken are popular throughout the Pacific Islands, and are raised mainly for home consumption. In most of the territories eggs are produced in small volume for the market, but per capita consumption is small compared with Hawaii and continental U.S. consumption.

Types of Agriculture

Agriculture in the territories can be classified into four types: (1)

subsistence smallholder, (2) semicommercial smallholder, (3) commercial smallholder, and (4) large-scale commercial farming. Characteristics of each type are given below. In most of the territories, subsistence and semicommercial smallholder agriculture are the prevalent types, but in Guam and to a lesser extent the CNMI, there is a commercial smallholder industry and some instances of large-scale commercial farming. As defined her, large-scale commercial farming does not have to be large by continental U.S. standards; the distinguishing characteristics are consistent use of paid employees and high input (capital intensive) technology.

Subsistence smallholder--Family (or clan) member(s) using traditional cropping or gathering techniques to produce for family consumption. Commodities are seldom marketed. Number of commodities produced is usually greater than for commercial smallholder.

Semicommercial smallholder--Individual or family member(s) regularly producing commodities for the market, but only on a part-time basis. Farming may or may not be regularly for home consumption (farmer may have full-time wage job in money economy). Commodities may or may not be produced using modern technology.

Commercial smallholder--Individual or family member(s) producing solely or substantially for the market. Commercial smallholder are typically full-time producers who derive their principal livelihood from farming. Commodities are normally produced utilizing modern technology. Range of commodities is much narrower than for subsistence smallholder. The commercial smallholder may have a few wage employees, but most would rely solely on unpaid family labor.

Large-scale commercial farming--Usually would be characterized by significant capital investment in operation, and use of paid wage and salary workers. Ownership would normally be corporate in form, with production utilizing modern, high input technology. Output per unit of land or labor input would tend to be much higher than for smallholder.

Modern technology is defined to be the package of practices (agronomic methods and procedures, as well as use of labor and material inputs) developed by scientifically based institutions (experiment stations, agriculture departments, specialized institutes) for use in tropical and semitropical areas. A package of practices relates to a given farm commodity or enterprise, and tends to be unique to a particular region. Packages of practices based on modern technology enable a farmer to obtain the highest yields possible on his land. Yields would be maximized with respect to the scarce resource (i.e. per acre per crop, if land is scarce; per man hour, if labor is scarce).

Subsistence Production

No consistent measure of non-market production has been derived for the separate territories. In Table B are noted indicators of agricultural production not entering and entering, respectively, the money economy. The terms subsistence and market (or commercial) agriculture are used in respect to all areas, but the specific island context is important. For example, in Guam, non-market production is largely of the home garden variety, but except for scale and use of machinery, the technology for producing commodities does not differ substantially from the commercial grower whose output is marketed. Guamanian households are virtually all a part of the money economy, and few depend on farming for the food they eat. In contrast, in an area such as Palau subsistence typically not only means use of a different technology, but also that for many families, the main source of the family's food is from subsistence farming.

While Table B indicates in a rough way the relative proportion of agricultural activity which is non-market as opposed to commercial, the information must be related to the following section on relative importance of agriculture in the economy. While direct measures were unavailable for the Marshalls and Palau, other data indicate that agriculture is mainly subsistence in both areas.

Relative Importance of Agriculture in Economy

Marketed agricultural production is quite small relative to total food consumption in all the territories. However, in the Compact States subsistence agriculture still accounts for a significant share of consumption. In Table C, the best available data are presented which indicate the volume of marketed production compared with total acreage in agricultural use. Available data on number of farmers is also given. Income and product accounts data for some of the territories indicate the relative size of agriculture in the overall economy, and where these data are not available other data are examined to obtain an idea of the importance of agriculture.

Sales at the farmers' market in Fagatogo in Tutuila averaged about 2.3 million pounds in the 1981-1983 period. The only data on acreage in crop and number of farmers was for 1979, when an estimated 1,735 acres were used for both subsistence and commercial production. There were an estimated 110 commercial farmers in 1979. In terms of relative importance in the overall economy, agriculture is not significant. Food imports per capita amounted to $530 in 1983, a high import level. Also, almost 60% of the 16-65 years old age group was in the money economy labor force in 1983, while agriculture employment was nil (just over 100 in 1979) (Economic Development and Planning Office, 1984).

In Guam, as in A. Samoa, the money sector labor force largely accounts for the economically active population, and only 140 persons were employed in agriculture in 1983. For the 1972-1976 period, annual GDP (gross domestic product) estimates were compiled. These estimates pegged value-added in the agriculture sector at less than 1% of GDP (Krueger, 1978).

The relative importance of agriculture in the CNMI is comparable to that in Guam--most of the population between 15 and 65 is either a part of the wage economy, in school, or fully occupied with family responsibilities. Of the employed labor force, very few are in agriculture. It is estimated that less than 80 full-time commercial farmers currently produce about 80% of total crop production, and a very large proportion of beef and milk output is from a single corporation. Total agricultural sales in recent years have been less than $3.0 million, while the estimated 1983 GDP was $179 million (Planning and Budget Office, 1984).

In the Marshall Islands subsistence agriculture represents a significant, but unknown, percentage of GDP, which was estimated to be $1,003 per capita in 1981. After taking into account U.S. government grants and transfer payments from abroad, national disposable income in 1981 amounted to $1,619 per capita, while food imports in 1982 were only about $150 per capita. Also, 3,000 persons were estimated to be economically active in subsistence agriculture, forestry, and fisheries in 1980 (Office of Planning and Statistics, 1984).

Subsistence agriculture is also important in the Federated States, in which approximately 38% of the $106.5 million GDP was attributable to the subsistence sector (including fishing) in 1983. Marketed production amounted to $4.32 million in 1983 (Table B), but except for copra (Table C), no breakdown by commodity was available. In total, the agricultural and fishing sector represent 42% of the FSM economy (National Plan Task Force, 1984).

Subsistence agriculture in Palau, similar to the Marshalls and FSM, represents a significant share of GDP. In 1976 an estimated 20% of the work force was in subsistence agriculture and fishing, and many in the wage economy farmed on a part-time basis for home consumption (Palau Legislature, 1976). Food imports in 1983 amounted to about $260 per capita, only half that of A.

Samoa (State Department, FY1984).

AGRICULTURAL DEVELOPMENT--CONSTRAINTS AND OPPORTUNITIES

In past times the Pacific Islands were self-sufficient in food production, but increased population, foreign cultural influence, and in recent decades large per capita U.S. expenditures, have contributed to a dramatic decline in agriculture to its present situation (Mark, 1982). This section discusses constraints to and opportunities for agricultural development in light of current conditions.

Constraints

Biophysical

Biophysical considerations include availability of land and water resources, soils, topography, and climate. In general land is in limited supply in the Pacific Islands; quality of soils, population density, land tenure, and topographic circumstances determine the degree to which land is a constraint. The SCS completed soil surveys of A. Samoa, the FSM, and Palau in the early 1980's. Similar surveys have not been completed for Guam and CNMI. Arable land acreages and population density (persons per arable acre) are tabulated below:

AREA	ARABLE AREA	DENSITY
A. Samoa	14,000 acres	2.45
Guam	6,900*	16.41
CNMI	30,000*	0.65
Marshalls	NA	NA
FSM:		
Kosrae	17,900	0.35
Ponape	57,700	0.47
Truk	13,500	3.30
Yap	21,500	0.43
Palau	63,500	0.20

Source: SCS, 1982, 1983, 1984

*Arable land figures not comparable with other areas.

It should be emphasized that the above acreages are gross figures in that arable acreages include land that is being used for crop production, grazing, urban use, conservation, and other uses. Arable acreages are based on soils determined to be well suited to the production of adapted crops commonly grown in the area, and other identified crops not commonly grown in the area. For Guam, the arable area is based on a soil survey of those lands designated potential agriculture lands (9,920 acres) by the Guam Bureau of Planning in 1977 (M.E. Park, 1978). The bureau's potential agriculture lands exclude a large portion of Guam controlled by the military, as well as lands designated for urban and conservation use. The CNMI arable acreage is based on surveys sponsored by the Trust Territory government in the early 1970's and cover only Saipan and Tinian. Most of the arable acreage would need to be irrigated to be considered "good" or "fair" in terms of productivity for agriculture use (Planning and Budget Office, 1984).

Tropical soils in the territories have a number of limitations. High rainfall in most areas erodes the soil and leaches out basic plant nutrients. Forest canopy and vegetation is critically important for maintaining soil fertility by returning organic matter to the soil through the natural plant life cycle. In clean-tilled crop production, surface soils are more susceptible to loss of fertility through erosion and leaching, and loss of organic matter through exposure to sunlight. To overcome soil fertility problems associated with clean-tilled crop production, use of compost and organic fertilizers, return of crop residue to soil, application of lime, mulching, and crop rotation are required. On coral atolls and single coral islands, soils are very porous, consisting mainly of sand, and while conducive to growing coconut palms, are not suited for most other crops (SCS, 1983b).

Annual rainfall is generous in most areas, with a fairly even distribution during the year. However, in the northern Marshalls, and to a lesser extent in Yap, Truk, and the Marianas, there is a more distinct dry season which can bring drought conditions harmful to crop production. In the rainy season in Micronesia (June to December), tropical storms and typhoons frequently occur in some areas. Yap and Truk, and the northern Marianas are most susceptible to severe storms. A. Samoa also experiences destructive storms and occasional hurricanes.

Topography of the high volcanic islands is mountainous in the interiors with large portions of the land area consisting of steep slopes, which preclude most crops except traditional tree crops such as breadfruit and banana. The atoll and low islands frequently experience flooding and salt water damage to crops caused by storms and tidal surges. Water is scarce, and in most of islands, potable water must be obtained by catchments.

Social and Cultural

Social and cultural factors which act to constrain agricultural development include land tenure and clan value systems, acquired tastes for western foods, and attitude towards farming as an occupation. Traditional values of Micronesians and Samoans place great prestige on use rights to land. Within the clan or extended family, the cultivation or gathering of crops such as taro, breadfruit, yams, and coconuts is determined by communal needs, rather than by the economic return which could be obtained by marketing production. Decisions on land use are made by the clan or family head, and use of land is an integral part of the social system. For example, slaughtering pigs for fiestas or social gatherings involving the extended family is a part of fulfilling social obligations. The high prestige value placed on land results in increasing fragmentation of parcels over time, as ownership is retained in families that have increased in size (Mark, 1982 and 1984). High social value placed on land is accompanied by clan system values which require the sharing of production with clan members. The sharing extends to individual wage employment earnings as well. These traditional values toward land and the sharing of wealth and income, tend to inhibit individual initiative towards commercial farming. Reluctance to sell or lease land also makes it difficult to consolidate land into larger parcels to enable larger scale, more efficient farm operations. In areas such as Guam and the CNMI, leasing and selling land has become more prevalent, along with western economic values, as most households have become integrated into the wage economy. With the large increases in public employment and wage income resulting from U.S. government expenditures in the Pacific Islands, western consumption standards--particularly for convenience foods--have been increasingly adopted. Rice, flour, canned meat and fish, sugar, and beverages such as soda and beer are large import items. Prestige attached to Western foods, the influence of USDA school lunch and disaster relief food programs which have distributed large amounts of surplus processed foods, and convenience in preparation of processed foods have all been contributing factors in the popularity of imported food. Preferences for imported food lessen demand for locally grown crops, and have had a detrimental effect on nutritional status (Thaman, 1985). Farming as an occupation is generally held in low esteem by the younger generation of Pacific Islanders. Availability of high paying government jobs, and a western based education system which emphasizes white collar occupations, results in little interest by youth in agricultural occupations.

Economic

Limited markets for local production, high wage structure, USDA food programs, and lack of appropriate technology are major economic constraints to an expanded agriculture. Markets for locally supplied commodities are situated in the capital areas. Generally, outlets consist of combination retail/wholesale/importer market operations. Markets occasionally buy from farmers, but rely primarily on imported commodities for the constant supply needed to meet customer demand. Typically, farmers have difficulty in finding a market. The problem is that farmers only sell commodities occasionally (they farm part-time, and mainly for family consumption), and markets cannot depend on steady local supply, and in most of the territories quality of local commodities is typically low. This situation results in markets depending mainly on imported supply. Although farmers' markets exist in many of the capitals, they generally account for a small portion of total commodity sales. Inadequate facilities contributes to small volume, but the basic problem is the lack of steady supply by farmers committed to growing for the market on a regular basis, i.e. lack of commercial and semi-commercial farmers, as opposed to subsistence growers. Size of market is another major constraint inherent in island economies located at great distance from population centers such as Tokyo or Hong Kong. Territory populations represent limited market demand for any given commodity in the sense that commercial farmers using modern technology can produce all that can be sold on relatively few acres. For example, in Guam it has been estimated that with modern farming practices, including irrigation, only 226 acres would be required to supply almost 11 million pounds of fruits and vegetables (19 different commodities) per annum (Decision Analysts Hawaii, 1983). Small size of domestic market, in combination with lack of alternative markets such as processor and overseas buyers, result in a tendency to market gluts in areas such as Guam which have a commercial farming industry. Increased market risk is a major constraint to development.

Another disincentive to producing for the local market is the availability of USDA surplus food, which is free and available to many families through the extended family. In the CNMI, Guam, and A. Samoa, food stamp and school lunch programs distribute large quantities of food. For example, in Guam some 22,600 persons participated in the food stamp program in 1983, and received coupons worth $18 million in food purchasing power. The majority of the food obtained from markets with the food stamps is processed food which is imported from the U.S. In the FSM and other Compact Countries, USDA commodities are distributed through school lunch programs and for disaster relief (storm affected areas, for example). Disaster relief food shipments frequently continue for long periods after disaster occurrence (Mark, 1984). Large proportions of the work force in public sector jobs, also acts as a disincentive to farming. Government employment accounts for nearly half, or more, of the total money sector workforce in almost all of the territories. wage rates are consistently higher in the government than in the private sector. For example, in Palau the average annual wage in government in 1981 was $5,741, and in the private sector, $3,785. In Truk State, the average wage in government in 1981 was $3,512, compared with $2,071 in private industry (GAO, 1983). With the large number employed in government, nearly every extended family has at least one member working in government, and this purchasing power helps support at least part of the extended family. Farm productivity is generally low in the territories. Crop yields are low, whether measured by yield per acre or per unit of labor input. Guam and CNMI have raised productivity for some commodities, as a result of the University of Guam's research and extension program, but in the other territories modern farming technology is largely lacking. Low productivity discourages both subsistence and commercial farming, especially when families have access to USDA food, money income from government employment, or have wage employment.

Infrastructure

Constraints to development imposed by lack of infrastructure exist in varying degree in all of the territories. The main kinds of facility shortfalls are: farm roads, irrigation systems, transport facilities and service, and storage/refrigeration capacity. In the high islands, such as Palau and Ponape, farm roads are needed to enable the farming of areas which are currently undernourished or not farmed at all. During the dry season in parts of Micronesia, drought conditions frequently cause low crop yields and occasionally result in substantial crop losses. In the Northern Marianas, Palau, Yap, and the Northern Marshalls reservoirs, or other sources of water, and distribution systems are needed to increase crop yields. In those territories with populations dispersed over a number of atolls and islands, inter-island surface transportation is typically inadequate to provide farmers with market access and farm inputs such as livestock feed and fertilizers. Interisland shipping service and associated harbor docking/storage facilities need to be upgraded to enable an expansion of agriculture. Likewise, potential for intraregional commodity exports in Micronesia, and exports to Hawaii and Asian countries will not be realized without improved transportation services--particularly in the Compact States and A. Samoa. There is little or no regularly scheduled surface shipping between the Compact States and Asian-Pacific cities outside Micronesia. The same situation exists in A. Samoa. Storage and refrigeration facilities are limited in all areas, particularly in the Compact States. These facilities are needed to facilitate development by providing for an increased and steady supply of domestic commodities, and to improve quality.

Opportunities

The constraints previously discussed represent formidable obstacles to development, but potential opportunities exist for increased production in virtually every territory, assuming a greater commitment to agriculture than has been the case in the past.

Import Substitution

Food imports are substantial in every territory. For example, in A. Samoa food imports averaged $18.6 million in the 1981-1983 period (Economic Development and Planning Office, 1984), and in the CNMI food valued at $23.2 million was imported in 1983 (Planning and Budget Office, 1984). Also in 1983, FSM food imports were $11.2 million (National Plan Task Force, 1984), and in Palau, $3.4 million (State Department, FY1984). In the Compact States, subsistence agriculture is still substantial, but urban populations are consuming more non-traditional fresh fruits and vegetables. The non-Micronesian population in the urban centers account for part of this demand, but prestige attached to imported foods and greater awareness of nutritional benefits of fresh produce may also be contributing factors. A large proportion of the fresh fruit and vegetable commodities which are imported could be produced in most of the high islands of the territories. Examples are pineapple, papaya, cucumber, egg plant, bell pepper, citrus fruit, sweet corn, tomatoes, avocados, green onions, Chinese cabbage, and head cabbage in

Ponape (Mark, 1984). The SCS has determined on the basis of its soil surveys, that most of these commodities also can be grown in Palau, Yap, Truk, Kosrae, and A. Samoa (SCS, 1982,1983,1984). In the Marianas, a wide range of fruit and vegetable commodities are already grown commercially, and view of resident's tastes for fresh produce, there is good potential for increased import substitution. USDA FOOD PROGRAMS With the ending of the Trusteeship, USDA food programs per se will terminate in the Compact States. In lieu of food and other social programs, the Compact States will receive block grants. The individual governments may use block grant funding on social programs of their own design (Schwalbenberg, 1984) If the school lunch program is discontinued, USDA supplied commodities will no longer be available, nor will USDA funds for schools purchase of food from local markets and farmers. In Ponape State in 1983-84 the school lunch program amounted to about $1.3 million, of which only about $0.2 million was spent on commodities supplied by local farmers (Mark, 1984). Since the school lunch program serves nutritional as well as income support purposes, a portion of the block grant funds could be used to purchase locally produced commodities, including processed items. In A. Samoa, Guam, and CNMI, opportunity exists to gradually shift the current food stamp and school lunch programs over to progressively higher domestic production content. In the CNMI, the program was modified to require that 25% of food stamp expenditures go to the purchase of locally produced commodities. The 25% requirement increases demand for local production, thus benefiting domestic farmers, but similar requirements could be extended to Guam and A. Samoa.

Increased Subsistence and Commercial Production

In addition to increased domestic production for import substitution, there is substantial scope for increasing both subsistence and commercial agricultural production of traditional crops, as well as other crops which are not imported but could be grown locally if domestic demand could be developed. Although semicommercial and commercial farming can be expected to become proportionately larger given a sustained agricultural development program, initially, packages of practices for traditional crop and livestock commodities could be developed to raise subsistence productivity. With respect to commercial farming, modern technology already available in other tropical areas can be adapted to selected locally produced commodities.

Pork and Poultry Industries

In every one of the territories, pork and chicken meat are popular food items, and also play an important role in traditional social life. Only in Guam is commercial egg production significant, but in the other territories local production is small, per capita consumption is low, and most eggs are imported. The critical element necessary for realizing a large expansion in the production of these commodities is lower cost feed. The high cost of imported feed precludes significant commercial production of pork in virtually all the territories, and all but Guam with respect to eggs.

Tourist and Military Markets

In Guam, CNMI, and the Marshalls, military and/or tourism represents potential demand for agricultural products. To a limited extent farmers in Guam and CNMI currently sell commodities to the military and to hotels and restaurants serving the tourism industry. Military personnel and dependents in Guam make up roughly 20% of the resident population, and annual visitors exceed 300,000, therefore these population segments significantly augment market potential. In the CNMI, tourism is the leading private sector activity. Hotel rooms number almost 1,000, and prospects for continued growth in visitors is considered good. Although there are no major military bases in CNMI, the commonwealth covenant provides the U.S an option for basing forces on Tinian Island. In the Marshalls, the U.S. has a large missile testing base at Kwajalein which has a population of about 7,500, most of which is Marshallese employees and dependents living on Ebeye Island. Fresh produce is currently nearly all air shipped into Kwajalein from suppliers outside of Micronesia. The Taiwan government has a technical assistance project in Majuro which consist of an experiment station and demonstration farm for producing fruits, vegetables, and poultry. Marshallese farmers could supply at least part of the fresh produce requirements for the Kwajalein base.

Export Potential

Currently the best prospects for exports outside of Micronesia are in Guam and the CNMI, which have frequent air service between Japan and other Asian-Pacific tourism markets. The wide-body passenger aircraft have (although limited) capacity to ship air freight containers. Japan is the most promising potential export market, mainly because of its high per capita income and already large volume of imported fruits and vegetables. A study which addressed the export potential for Guam commodities, concluded that avocados and papayas had the best export potential in the Japanese market, with other possible exports being tomatoes, sweet corn, bell pepper, melons, and ornamentals. However, Japan has strict plant quarantine regulations, and since Guam has several varieties of fruit flies, fresh produce from Guam in on Japan's prohibited list. Guam would need to find a method of treating commodities to eliminate fruit flies and also would have to obtain Japanese government approval to export commodities into Japan (Decision Analysts Hawaii, 1983). In the Compact Countries export potential is probably greatest with respect to high value (per unit weight), easy to ship or process commodities such as black pepper which Ponape exports in small volume. Other possible high value commodities which can be grown in the high islands include clove, cacao, cinnamon, nutmeg, vanilla, cashew nuts, and coffee (SCS, 1982, 1983). Opportunities for intra-regional trade are also possible for certain commodities such as sweet corn, bananas, pineapple, papaya, and selected vegetables. Coordinated agricultural development planning among the Micronesian territories would enable some degree of specialization for areas with a comparative advantage for particular commodities. given commodities. Development strategy The assessment of agricultural development constraints and opportunities in the previous section provides the basis for an appropriate strategy for sustainable agricultural development in the territories. Rationale for an emphasis on smallholder agriculture is presented, and the institutional support needed to implement the development strategy is discussed.

SUMMARY OF CONSTRAINTS AND OPPORTUNITIES

Constraints

Major constraints to agricultural development which apply to all of the Pacific Islands include low soil fertility, limited arable land of given soils type and level topography, land tenure systems characterized by fragmented land holdings and clan influence over use rights, small size of domestic markets for agricultural products, lack of high productivity packages of practices for crop and livestock commodities, availability of high paying government jobs, lack of rural farm roads in high islands and transportation to markets from outlying islands, high cost of imported livestock feed and other inputs, and distance to overseas markets. The degree to which the above constraints apply varies among the Territories, but nevertheless are significant in all of them. For example, there is more arable land area in Ponape and Palau relative to population than in the Marshalls, Truk, and A. Samoa, but even in Ponape and Palau, arable land available for crop production typically is owned in relatively small parcels, is small in area with respect to flat terrain and in terms of contiguous soils of a given type (i.e. soils suitable for a given crop). Some constraints tend to apply only to certain of the territories. These include significant dry seasons in the Marianas, northern Marshalls, Yap, and Palau. In these areas lack of irrigation limits farm productivity. The incidence of destructive typhoons and other tropical storms also tends to be much greater in the Marianas and more westerly part of the Carolines.

Opportunities

Opportunities for agricultural development which are common to the territories include significant potential for import substitution in terms of fruits and vegetables, and pork, chicken and eggs (if feed costs can be lowered); potential for increased local production to provide commodities for school lunch and/or food stamp programs; availability of high productivity packages of practices which if adapted to local conditions can substantially increase farm productivity; potential for developing at least a few high-value commodities, such as spices, for export. For Guam and the CNMI, tourism represents a market segment of significance in terms of supplying commodities to hotels and restaurants. Tourism is already significant, and the Japanese tourist market is expected to continue to grow. Tourism in the Compact States and A. Samoa is adversely affected by currently weak airline linkages with major Asian/Pacific markets and relatively expensive fares. Trade in agricultural commodities within Micronesia also is possible with respect to selected commodities. The potential for intra-regional trade depends both on coordinated development planning and strengthening surface and air transportation services among the territories.

Smallholder Development Strategy

The nature of both constraints to and opportunities for agricultural development in the Pacific Territories calls for a smallholder development strategy. Conditions in the islands are almost universally adverse for large-scale commercial farming. Capital investment for both land and technology required for large-scale farming in most cases would have to come from outside investors, except that land cannot be owned by non-citizens, and although land may be leased, property interests cannot be secured by mortgage liens because of inadequate (or no) mortgage laws. Large-scale commercial farming would require large markets to absorb production volume, and this would necessitate export markets. While export potential exists, it is very difficult to achieve. With respect to soils, large-scale farming would need large acreages of soils suitable for a given crop, and for most crops would have to be fairly level to accommodate mechanization and other farm management practices necessary for high productivity. Large parcels of land of a given soils type would be difficult to find in most of the territories. The clean-till, equipment intensive type of farming characteristic of large-scale commercial farming also would require larger inputs of fertilizers and other soil amendments to maintain crop yields. Risks of erosion and other ecological damage would be significantly higher than for the less capital intensive smallholder commercial farming. Also, in most of the territories, the supply of skilled labor needed for large-scale commercial farming would be limited.

While opportunities for large-scale farming may be exploited by investors willing to bear the high risks and potentially very high returns associated with a successful export commodity, the greater likelihood of success and benefits of a smallholder strategy make this the preferred policy option. Compared with large-scale farming, the benefits associated with a smallholder development strategy include less risk of adverse affect on traditional social system; larger employment generating effects; broader distribution if increased farm income; greater compatibility with island ecological conditions; less dependency on imported production inputs such as chemical fertilizers, herbicides, and other inputs; more widespread and beneficial impact on diets and nutritional status; and greater diversification within agriculture, and therefore less susceptibility to events such as a plant disease.

A smallholder development strategy takes advantage of the already existing large number of subsistence farmers (Compact States) and part-time farmers (A. Samoa, Guam, and the CNMI), and is more compatible with the present land tenure systems than a policy of promoting large-scale farming would be. Another strength of the small-holder strategy would be that smallholders would produce a larger range of commodities, the marketing of which would be easier in light of small size markets. It could be expected that increased market supply would largely be in terms of import substitute commodities, which would likely mean lower commodity prices for residents. Also, a strategy which is likely to emphasize import substitution (at least in the early stage of development) is more likely to succeed and be less costly than attempting to promote large-scale farming which would be export oriented, and thus more costly to develop and less likely to succeed.

Among the three types of smallholder agriculture, competition for resources and other adverse effects is not likely to be a concern. Relative policy emphasis should depend on conditions in the particular territory. Moreover, the three types of agriculture have many characteristics in common. Common characteristics would be relatively modest acreage requirements per operation, heavy reliance on family labor rather than hired wage employment, and significantly less capital requirements per operation compared with large-scale agriculture. Smallholder development strategy would recognize present stage of development as a condition and seek to achieve a transition. For example, in the FSM there are presently no commercial smallholder farmers; most farmers are either subsistence or semi-commercial. Initially the FSM should seek to raise productivity in the subsistence sector, particularly in outlying areas which have arable land but lack transport and other infrastructure needed for market access. At the same time efforts should be initiated to strengthen urban markets for semi-commercial farmers, and develop more productive packages of practices for selected import substitute commodities.

In the Marianas, semi-commercial and commercial smallholder agriculture currently accounts for the majority of production; therefore Guam and the CNMI would focus on these types of agriculture, with the objective being to achieve a predominantly commercial smallholder sector. Emphasis would be on market development for import substitute and traditional crops, and development of higher productivity packages of practices emphasizing the needs of commercial smallholders.

One of the prime objectives of the smallholder strategy would to achieve a transition whereby subsistence farming gradually gives way to semi-commercial, and ultimately commercial smallholder agriculture. A basic premise underlying the agricultural development strategy is that in every one of the territories the private sector must be made more productive to support standards of living that residents have become accustomed to; and further, that economic development options other than agriculture are sufficiently limited so that territorial governments cannot ignore agriculture's development potential. Since imports constitute the bulk of consumption, for territories to ultimately achieve their goals of being economically self-sufficient, they must either locally produce the goods they consume, or they must generate overseas earnings through commodity or services exports to pay for the imports. Given the currently large food imports in most of the territories, domestic agriculture can contribute to the ultimate goal of overall economic self-sufficiency by producing for import substitution or for export--in either case, agriculture would have to become increasingly commercialized.

In view of the pervasive nature and severity of the constraints to development, it should not be expected that self sufficiency, or even near self-sufficiency, can be achieved in domestic food production. A more appropriate goal would be to utilize lands best suited to crop production to the maximum extent possible, taking into account other land use requirements. Large amounts of arable lands simply would not be farmed.

LEGISLATIVE AND INSTITUTIONAL SUPPORT OF DEVELOPMENT STRATEGY

Congressional Action

Appropriate objectives of Congressional action would include the following:

(a) Support of research and extension program focused on the needs of smallholder farmers. The Compact does not explicitly provide for U.S. agricultural assistance. The Compact States will receive general and block grants for 15 years (except Palau), over which they apparently will have large discretion in terms of how the funding is used. [Recently enacted legislation approving the compact may include changes in the provisions.] Congress must concur in the development plan which each State is required to submit to be eligible for Compact funds, therefore it has leverage to influence the agricultural development program. In the case of the CNMI, Guam, and A. Samoa, Congress through its appropriations authority can effectively support an adequate research and extension program.

(b) Support the establishment of a regional coordination mechanism for agricultural development. Presently, the Pacific Basin Development Council promotes and facilitates coordination of economic development of A. Samoa, CNMI, Guam, and Hawaii. This or a similar institutional arrangement should be established to coordinate economic development (including agriculture) of all the territories, including the Compact

States.

(c) Support modification of the food stamp and school lunch programs in A. Samoa, CNMI, and Guam to provide for purchase of food from local smallholder farmers to the maximum extent possible, given local conditions, instead of using USDA surplus commodities (for school lunches) and imported food (purchased in markets with food stamps). For example, in the latter program, USDA/territorial government would agree on the percentage of food stamp monies that merchants would be required to use for purchasing local farm commodities. This is essentially the case in the CNMI now, but not in Guam or A. Samoa.

(d) Seek assurances from the Department of Defense that its policies and procedures for food purchasing are resulting in the largest possible use of locally produced commodities in Guam and the Marshalls.

Local and U.S. Government Policies, Programs, and Regulations

The following local and U.S. government policies, programs, or regulations support or constrain agricultural development:

(a) Soil Conservation Service--The SCS program has been extended to Guam, but with respect to the other Territories only soil surveys have been done (except in the CNMI). Given the generally thin tropical soil, high rainfall, and rugged topography in the high islands, soil conservation is a priority need. The SCS program should be extended to all of the territories. In the Compact States the U.S. program should be offered until such time that local government expertise and resources are adequate to run their own program.

(b) Land Grant Programs--The University of Guam, the Territorial Community College in A. Samoa, and the College of Micronesia (COM) (which is comprised of three community college campuses located in a Palau, Ponape, and Saipan) are Land Grant institutions, and therefore are eligible for U.S. Hatch, Smith-Lever, and Bankhead Jones Act funds for agricultural research, cooperative extension, and instruction in agricultural education, respectively. The COM is currently in process of implementing land grant research, extension, and instructional programs, but with Compact approval funding for these programs may be terminated. The Marshalls, the FSM, and Palau all are served by the COM. Presumably the Saipan campus of the COM will be placed under CNMI jurisdiction with the termination of the Trusteeship, the Saipan campus has no agricultural programs. Similar to the COM, the Territorial College in A. Samoa is just beginning to implement land grant programs.

(c) Mortgage Laws--In most of Micronesia, except Guam, mortgage laws are nonexistent or inadequate to enable commercial banks to make loans secured by real property. Agricultural development will require availability of farm loans, and inability to use real property to secure loans is a constraint. Territorial governments should enact adequate mortgage laws to eliminate this constraint.

(d) Informational Needs--Agricultural statistics on crop and livestock production, land use, commodity sales, production costs, and measures of productivity are virtually nonexistent in the Compact States and A. Samoa, and need to be improved in the CNMI and Guam. Effective agricultural planning and program implementation will require at least some of the above kinds of data. Territorial agriculture departments, planning, and land use agencies should obtain technical assistance from U.S. or international agencies to upgrade their statistical programs.

Actions Needed for Development Strategy Implementation

This section discusses those actions which should be afforded high priority to enable implementation of the smallholder agricultural development strategy. Actions addressed are not intended to be all inclusive, but rather to focus on those which are judged to be most critical for the success of the development strategy. Actions must be part of a comprehensive program which entails coordinated implementation program components. Given actions will not succeed if complementary components are neglected.

Government Commitment

In view of the pervasive constraints, cost, and time (usually decades) required to obtain substantial benefits from agricultural development, a strong government commitment is essential. Both U.S. federal and territorial governments must be committed. Strength of the commitment can be measured by financial and personnel resources allocated to the program, and progress that is made toward predetermined development plan objectives. Current development plans (draft versions) required under to Compact of the FSM and Marshalls indicate agriculture funding allocations of $15.9 and $2.3 million, respectively, for the 5-year 1985-89 period. These funding levels, especially for the Marshalls, may be too small to fund an effective development program.

Other indicators of commitment would be the steps taken by the territorial governments to strengthen farm commodity markets, upgrade research and extention capacity, implement agriculture vocational and technical programs in secondary and postsecondary schools, and determine needs of farmers through improved communications. Government action, including promotion of agriculture as a vocation and as an important industry is needed to counteract the generally negative image of agriculture held by youth and the general public. To farmers especially, these indicators of commitment would tend to encourage and promote better communications and interest in utilizing extension and agriculture department services. Farmer cooperation also is essential in obtaining much of the data needed for effective planning and program management.

Targeted Commodities Program

A task force should be established in each territory to identify commodities that should receive priority for market support, research, and extension. Technical, economic, nutritional, and social factors, as well as available resources need to be considered in selecting commodities for promotion. Task force members should include farmers and other private industry representatives with an interest in agriculture. Technical factors should include an appraisal of the relative difficulty of adapting overseas technology to local conditions.

Technology Development Program

High productivity packages of practices are needed to increase the profitability of farming. Increased productivity in subsistence farming, while not relevant to profitability, creates the incentive to engage in semi-commercial farming. Likewise, increased profitability encourages the transition from semi-commercial farming to a proportionately greater number of commercial farmers. Given all the constraints affecting farming in the territories, commercial farming is highly risky. Significant increases in productivity are needed to create a favorable risk/return environment for farming.

Research and extension programs in territorial agriculture departments generally have not adapted existing high productivity technology from other tropical areas such as Hawaii, Taiwan, and other areas (Guam is an exception in that it has an experiment station program, but even in Guam technical assistance and increased resources will likely be needed to support a successful development program).

Development of high productivity packages of practices adapted to local conditions is made possible by the advances in tropical agriculture in many countries, and through the work of both internationally supported agricultural research and training institutes and public universities in the U.S. and other countries. A package of practices may be thought of as a commodity specific technology. It is a term used to refer to all the components of a farming system used to produce a given commodity (in a multicropping system the term would refer to the several commodities produced by the system). components include method of preparing soil for planting; planting; weed control; measures used to prevent or control plant disease or insect infestation; uses and methods of applying fertilizers and other soil amendments; harvesting practices; post-harvest on-farm commodity handling, processing, and storage; methods of packing and transporting commodities to market; and marketing practices.

Each of the many commodities grown commercially in Hawaii (and other countries with advanced tropical agricultures), is associated with a package of practices. In Hawaii, papaya and ginger root are two examples. The papaya industry is now a mature export industry in Hawaii. In 1945-1946, total production was about 6 million pounds, with about 400 acres in bearing crop. All production was for the local market (Doue, April 1966). Exports of papaya to the continental U.S. began in the early 1950's, and have increased to a very substantial volume--in the 1980 to 1984 period averaging about 40 million pounds per year. Total production during this period averaged about 62 million pounds per annum, with harvested acreage of about 2,200 acres. Yield per acre has increased from a pre-1950 level of about 15,000 pounds, to about 30,000 pounds currently (Doue, April 1966; and Hawaii Agricultural Reporting Service, July 1985).

As a significant commercial crop, ginger root is a relatively new industry in Hawaii. Acreage harvested in the 1959-1963 period was about 25 acres, and production about 600,000 pounds per annum, with about one-third being exported. Since 1978 the ginger root industry has been expanding rapidly, increasing from 55 acres to 135 acres harvested in 1984. Most of the production is currently exported. Yield per acre has increased from about 25,000 pounds in the 1959-1963 period to about 38,000 pounds in the 1980-1984 period (Hawaii Agricultural Reporting Service, 1966 and 1985).

Increased crop yield in relation to the cost of production (i.e. increased productivity), is typically a prerequisite for commodity industry success. For Hawaii's papaya industry, increased yields during the formative years of the industry were attributed to development of higher yielding plant varieties, and more effective control over diseases and insect pests (Doue, April 1966). The package of practices in use by an industry at any given time is the product of many innovations made over time. Many, but by no means all, innovations are the result of applied research and development. Developing higher yielding, disease resistent crop varieties is one example. Determining pesticide and fertilizer applications which are cost-effective, and environmentally safe for a given crop is another example of a biologically related innovation. Besides biological innovations, engineering, marketing, and other agribusiness and instituional innovations are of obvious importance in contributing to high productivity packages of practices.

Although high productivity packages of practices are available, the process of adapting them to the U.S.-Affiliated Pacific Islands will require time and considerable cost, but can be accomplished. The South Pacific Island nation of Fiji has developed a substantial agriculture (currently accounting for about 22% of GDP, 90% of export earnings, and 55% of total employment (Central Planning Office, November 1985)). Two of the commodities Fiji is giving priority to are ginger root and papaya (pawpaw). Almost 400 acres are in ginger root, with about 9.2 million pounds produced in 1984. Nearly all of the ginger is exported. An estimated 560 smallholder farms produce the ginger crop. With respect to papaya, the industry is a new one in Fiji, producing about 250,000 pounds per annum mainly for the domestic hotel sector. The papaya industry is expected to become a significant export activity, with Japan the major market (Central Planning Office, November 1985). In both the ginger and papaya industries, Fiji growers have come to Hawaii to observe farming practices, and in the case of papaya, to obtain Hawaii plant varieties. Although not undertaken in context of a formal assistance program, Fiji is believed to have benefitted from the advances made in the Hawaii ginger and papaya industries (Chung, April 1986).

There exists more than a dozen international agriculture research and training institutes established to assist developing countries. (Many of the institutes are part of the consortium, Consultative Group on International Agricultural Research (CGIAR), which is supported by several private foundations and many of the developed countries, including the U.S. (Wortman, 1978)). The Asian Vegetable Research and Development Center (AVRDC) in Taiwan, and the International Institute of Tropical Agriculture (IITA) in Nigeria, are two which have research programs relevant to the Pacific Islands.

(AVRDC is not part of the CGIAR) The focus of AVRDC is six vegetable crops, including sweet potato, tomato, soybean, mungbean, white potato, and Chinese cabbage. The commodities were selected as those representing the best in terms of economical sources of essential nutrients, and for their potential to increase the incomes of small farmers.

The AVRDC program includes working with cooperative researchers in other countries. Particular success has been achieved in hybrid tomato varieties. Varieties have been developed which bear fruit at high temperatures; some varieties have resistence to bacterial wilt, and some others are tolerant of flood conditions. The University of Guam Agriculture Experiment Station has done cooperative research on hybrid tomato lines supplied by AVRDC (University of Guam, 1978). Besides Guam, Tonga and Tahiti have benefitted from the AVRDC program (Grosse, December 1981/-January 1982).

The IITA focus is on the humid and subhumid tropics, and includes research and training for crop improvements in rice, maize, cowpeas, soybeans, yams, sweet potatoes, and cassava. The institute also emphasizes the area of farming systems. Although most of IITA's research is concerned with areas in Africa, it has a global mandate with respect to cowpeas, yams, and sweet potatoes. Vegetable cowpea varieties have been developed which are of the bush type rather than the traditional vine types which require costly trellis support or staking to keep pods from touching the ground and rotting. These lower cost varieties have been developed and tested in the Philippines and Sri Lanka (International Institute of Tropical Agriculture, 1985).

Each territorial government must take the initiative in developing technology appropriate to raising smallholder productivity in its area. The expertise and resources in any one of the territories is not adequate to accomplish the task alone. Technical assistance from the international institutes, University of Hawaii, Australian or other agricultural schools should be drawn upon to develop the high productivity packages of practices for targeted commodities. Technical assistance for training extension agents in application of the new technology also will be needed.

In A. Samoa, CNMI, and Guam this program could be funded from Land Grant resources, augmented to the extent necessary by additional U.S. federal funds appropriated by the Congress. For the Compact States, if the COM is no longer eligible for land grant funding, such funding must come from compact monies. To the extent that compact monies are not sufficient, the Congress would need to provide funding--either directly to the Compact States or to the University of Hawaii (or other U.S schools with tropical agriculture expertise) to provide the technical assistance.

Strengthen Local Markets

Territorial governments must take the initiative in strengthening local markets for agriculture products. A number of actions are possible to provide incentives for increased production, increase demand, and improve market efficiency. A commodity support program is one possibility. Market intervention through a commodity support program could entail setting minimum support prices. If farmers' could not sell commodities in the private market, the territorial government would purchase the commodities. Support prices should be set below prevailing average market prices and in general should only apply to import substitute commodities judged capable of being competitive with imports after a predetermined development period. Commodities purchased by the government could be used in school lunch programs. Another strengthening measure would be to establish import duties for selected commodities which competed with the targeted locally produced commodities. Once commercial farming becomes established in a given area, private marketing cooperatives can be formed to coordinate production timing among farmers to provide for steady supply and avoidance of market gluts, to establish quality and packaging standards, and to contract supply and prices with markets and other buyers (education departments, military bases, and hotels). Where there is difficulty in getting farmers to establish and use a cooperative, and government may need to provide financial assistance as an incentive.

Processing Facilities

Processing plants for food commodities and livestock feed are critically needed. Both types of processing are difficult to establish given the small populations in the territories and the economies of scale associated with such facilities. With respect to food processing, some commodities are more amenable to relatively simple kinds of processing technologies. For example, aseptic packaging offers a relatively cheap method of packaging juices, milk, cut up fruit (up to 3/4" cubes), and other liquids in paper or cheap plastic containers (Department of Planning and Economic Development, 1984). Territorial research agencies, in conjunction with agriculture departments probably would need to contract with outside experts to conduct feasibility studies of commodities having potential for processing. Success in establishing processing industries would provide substantial benefits to farmers by increasing market demand and offering an alternative outlet which can absorb supply not taken by the fresh produce market. The effect which processing demand would have in moderating supply fluctuations would contribute to increased market efficiency.

With respect to feed processing, again territorial government research and agriculture departments probably would need to contract for outside expertise to determine the feasibility of utilizing various locally available products as ingredients for poultry and swine feeds. If feed plants can be established in the territories, egg, pork, and possibly chicken broiler/fryer industries can be expected to grow substantially. Feed costs represent half or more of total costs of producing these livestock commodities, and currently imports of pork and poultry are large in all the territories. (In Ponape, feed costs account for well over half of total costs of production for both swine and chicken broilers (Szentkiralyi, 1976 and 1977; and Veratau, 1984). In Hawaii, feed costs represent 60 to 70 percent of total broiler production costs (University of Hawaii, January 1982)) In the Compact States and A. Samoa, imported livestock feed is used sparingly by farmers, with swine and chickens allowed to forage for most of their food. A potential secondary impact of lower feed costs would be increased consumption of eggs and pork, which is likely to have a beneficial impact on nutritional status of the population.

Transportation and Irrigation Facilities

In Palau and Ponape, and in other areas, farm and other secondary roads are needed to provide access to markets and to open up areas which contain agriculture land which is currently not accessible. Territorial governments initially should give priority to providing access to market centers, and secondarily to opening up new farm areas. Although infrastructure is generally being given high priority in the Compact States development plans, the amounts allocated to road construction may not be adequate to address farm needs. For example, in the FSM, $12.5 million is budgeted for the first five years, 1985-89, for transport development. According to the Ponape State Plan, local and farm roads cost between $100,000 and $200,000 per mile, which is probably representative of FSM road costs (Ponape State Government, 1983). Military Civil Action Teams (CAT) undertake road and other community facility projects of a similar nature. Under the Compact a single CAT team will remain in each FSM state for the 15 year compact period. Each team is comprised of about a dozen men and several pieces of heavy equipment. If priority is to be given agricultural development, it may be advisable for the U.S. to provide additional construction resources in the FSM and in Palau where farm and other secondary roads are a significant constraint.

Other infrastructure which is critically needed for agricultural development are irrigation systems in those areas which are subject to seasonal draught conditions. Provision of irrigation systems can be very costly, therefore decisions on types of systems and areas needing facilities should be closely evaluated to ensure cost-effectiveness. The U.S. Army Corps of Engineers recently completed a study for a proposed dam-irrigation system in Guam (Decision Analysts Hawaii, 1983). In support of agricultural development, funding could be allocated to the Corps to conduct feasibility studies of alternative irrigation systems for the CNMI, Yap, and Palau.

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TABLE A. PRINCIPAL CROP AND LIVESTOCK COMMODITIES

	COMMODITY		
AREA	CROP		LIVESTOCK
American Samoa	Taro		Eggs
	Banana		Pork
	Breadfruit		Chicken meat
	Coconut		
Guam	Cucumber	Sweet potatoe	Eggs
	Watermelon	Head cabbage	Pork
	Eggplant	Tomatoe	Chicken meat
	Chinese cabbage	Cassava	
	Banana	Yam	
	Taro	Melons	
	Green beans	Papaya	
	Avacado	Breadfruit	
Northern Marianas	Cucumber	Avacado	Eggs
	Watermelon	Breadfruit	Milk
	Other melons	Sweet potatoe	Beef
	Banana	Cassava	Pork
	Papaya	Yam	
	Taro	Mango	
Marshall Islands	Coconut		
	Breadfruit		
	Pandanus		
	Banana		
Federated States	Coconut	Breadfruit	Eggs
	Banana	Pandanus	Pork
	Black pepper	Citrus	
	Taro	Mango	
	Yam	Papaya	
	Cassava	Sweet potatoe	
Palau	Coconut	Sweet potatoe	Eggs
	Banana	Taro	Pork
	Cassava		

Source: A. Samoa (SCS, 1984; and Office of Economic Development and Planning, 1982)
Guam (Perry, 1983; and Economic Research Center, 1984)
Northern Marianas (Planning and Budget Office, 1984; and State Department, 1984)
Marshalls (Office of Planning and Statistics, 1984)
Federated States (Mark, 1984)
Palau (SCS, 1983b; and State Department, 1984)

TABLE B. SUBSISTENCE VERSUS COMMERCIAL AGRICULTURAL PRODUCTION

AREA	SUBSISTENCE	MARKET
American Samoa	1,405 acres (81%) in subsistence crops	330 acres in commercial crops
Guam	More than 1,000 family gardens, usually <.25 ac.	85 commercial farms <5 acres
	400 family farms <5 acres	40 commercial farms >5 acres
Northern Marianas	Approximately 20% of total production is for home consumption	Approx. 80% of Total production is for market
Marshall Islands	NA	NA
Federated States	$40.59 million is imputed value of subsistence agriculture & fisheries production	$4.32 million marketed production
Palau	NA	NA

Source: A. Samoa (Development Planning Office, 1980)
Guam (Perry, 1983)
Northern Marianas (Planning and Budget Office, 1984)
Federated States (National Plan Task Force, 1984)

TABLE C. ACREAGE, FARMS, AND CROP AND LIVESTOCK SALES

AREA	ACREAGE IN CROP	NUMBER OF FARMS	SALES CROPS	 LIVESTOCK
American Samoa	1979: 1,735 acres	Commercial:1979 Poultry 0 Swine 37 Taro 45 Banana 15 Vegetable 13 Total 110	1981-1983 Avg. (in '000 lbs.) Vegetables 669.2 Taro 669.0 Banana 942.4	
Guam	1981: 1,757 crop 678 pasture	1981: 2,044 Farmers 192 Full-time 1,892 Part-time	1981-1983 Avg. Fruits, Veg. &Staples: 4,996,000 lbs. $4,322,000	Poultry: 199,000 lbs. $68,000 Pork: 1,064,000 lb $842,000 Eggs: 1,200,000 do $1,540,000
Northern Marianas	1984: 600 crop 22,500 pasture	Commercial: 1984 (80 Full-time farmers	1982-1983 Avg. Fruits, Veg. &Staples: 923,500 lbs. $636,700 (1984)	1984: Eggs: 78,400 lbs. $84,200 Milk: 1,262,600 lb $314,700 Beef: 398,200 lbs. $510,600
Marshall Islands	1984: 22,000 acres in coconut	NA	1983: Copra: 6,490 tons Processed Value: $3,114,000 All other commodities: 7,200 lbs. (1984)	1983: NA
Federated States	1982: 47,430 crop	NA	1983: Copra: 4,216 tons Processed Value: $1,360,000	NA
Palau	1977: 4,300 acres	Commercial:1981 30 crop farmers 4 poultry "	1981-1983 Avg. Fruits, Veg. &Staples: 88,000 lbs. $40,300	Eggs: 22,500 do $37,700 Pork: 23,400 lb $28,500

Source: A. Samoa (Development Planning Office, 1980 and 1984)
Guam (Perry, 1983; and Economic Research Center, 1984)
Northern Marianas (Planning and Budget Office, 1984;and State Dept., 1984)
Marshall Islands (Office of Planning and Statistics, 1984)
Federated States (State Dept., 1982;and National Plan Task Force, 1984)
Palau (State Dept., 1977, 1981, 1984)

Background Paper No. 4

AN ANALYSIS OF BLACK PEPPER PRODUCTION IN PONAPE

by

Meredith Glenn

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ABSTRACT

The growing conditions for pepper in Ponape are among the best in the world. Experiments at the Ponape Agriculture Station have produced outstanding yields of 4-5,000 pounds of dried pepper per acre per year. The high quality, aromatic pepper of Ponape is easily marketable as a high priced "gourmet" spice, but the island has never produced more than 13,000 pounds of peppercorns per year.

Specialty Brands (Spice Islands) made a study of the feasibility of a 1,500 acre pepper plantation on Ponape in 1976. They concluded that despite a more than adequate number of unemployed Ponapeans as potential laborers, cultural conditions were such that they could not reasonably expect to be able to hire a dependable labor force. Specialty Brands called it a lack of a "work ethic" and decided against the plantation project.

Since 1977, recorded pepper production on the island has not exceeded 7,000 pounds a year. With the exact number varying from year to year, about 50 farmers cultivate a bit more than 20 acres of pepper vines on Ponape now. With Ponape's considerable potential, why haven't Ponapeans converted this opportunity to a better source of revenue?

Although some other factors are involved, the largely subsistence nature of Ponape's economy and the cultural background of its people keep production at low levels. The current system of many small farmers, each with limited acreage, has not been successful since the pepper program started in 1960. There is no reason to believe it will become successful in the forseeable future.

An updated feasibility study of a plantation style pepper production system should be made. With pepper prices currently at $1.72 per pound, experienced management might well be able to successfully produce and market much larger quantities of pepper, particularly in the "gourmet" market.

At this point, the U.S. can best help Ponape by providing the information necessary for Ponapean policy makers to come to a decision, and then assist in planning the most efficient, effective way to implement that decision.

GLOSSARY OF TERMS

C & RS	(Department of) Conservation and Resource Surveillance of the Ponape State government. Formerly, Department of Resources and Development. The Agriculture Division is one of this Department's 6 divisions.
C.I.F.	Cost, insurance, freight
EDA	Economic Development Authority of the Ponape State Government
F.O.B.	Free on Board. Usually written F.O.B. (place name). It means that shipping costs are paid as far as the location named.
NVEE	Non-volatile ether extract. When written as "% NVEE", it is a measure of pepper pungency. The U.S. minimum for black pepper is 6.75% NVEE.
PPCA	Ponape Producers Cooperative Association
PPGA	Ponape Pepper Growers Association
TTPI	(U.S.) Trust Territory of the Pacific Islands

I. HISTORY OF PEPPER IN PONAPE

The growing conditions for pepper (Piper nigrum) in Ponape seemed close to ideal when Trust Territory Agriculture Division staff were exploring cash crop potentials in the late 50's. (Migvar, Leo, 1967)

- Ponape's weathered soils are well drained, which is essential for pepper.
- Rotting vegetation has left a humus layer of up to 8 inches on the soil surface, and pepper must have well composted soil.
- Pepper cannot tolerate temperatures less than 60°F nor more than 100°F, so Ponape's daily temperature variation of 12.5 degrees within the 70° to 90°F range is exactly in a comfortable mid-range for pepper.
- Its shallow root system requires a minimum of 60 inches of rainfall per year. But since its flowers are water pollinated, Ponape's 190 inches of average rainfall distributed over 300 days not only keeps the vines properly moist but keeps them producing 12 months a year.
- Since only 37% to 50% of available sunlight reaches the ground because of almost constant cloud cover, pepper in Ponape can be planted in open fields and does not require intercropping among shade trees as it does in many other pepper growing areas of the world.

Pepper is a woody-stemmed, perennial, climbing vine, and it requires a support to grow on. In the wild, it will twine around rough barked trees but in Ponape, 10 foot stakes of mature (15 to 20 year old) tree ferns (Cyathea negricans) are used. Its rot-resistant hollow trunk is an ideal support for pepper, and since it is easily available at minimum cost on Ponape, the pepper industry there has an inexpensive local resource which simplifies starting pepper farms.

Pepper was originally introduced in Ponape in 1954, when cuttings from Fiji were planted at the Agriculture Station. Their survival, plus the existence of two related native species (Piper Ponapense and Piper methysticum, or sakau) resulted in a decision to try cuttings from several sources at the Trust Territory Farm Institute. The most successful cuttings, a Sarawak variety transplanted from Fiji, were introduced in 1960. Descendants of the original 300 cuttings of this variety have been the source of pepper plants for Ponape farmers since that date.[1]

The following listing of some of the key events in the history of pepper in Ponape shows some of the starts and stops of the program.

1960	1 acre of "Sarawak" variety cuttings planted at TT Farm Institute.
1963	1) Excellent first harvest of 1,158 lbs. of processed pepper, for an average yield of 5.8 lbs. dry pepper per vine. First year production costs were put at $.875 per lb., C.I.F. San Francisco. (Halvorsen, Robert, memo dated October 10, 1963. See Appendix A.) 2) Micronesian Spice Association formed to handle pepper sales.
1965	1) Since foreign investment was not permitted in Micronesia until April 1, 1974, the initial pepper development plan was to encourage 400 Ponapeans to plant 200 vines (1/6 acre) each by 1969. An interest free loan of $120 per 200 vines was made available to cover start up costs. 2) Pamphlets published (in English) by Literature Production Center, TT Headquarters, for use by farmers titled: "Black Pepper in the Caroline Islands" by Leo Migvar; "How to Establish a Pepper Garden" by D. Zaiger; and "How to Process Black and White Pepper," by D. Zaiger. 3) Purchase offer received from Trade Routes (Baltimore Spice Co.) for black pepper at 40¢ per pound. (Trade Routes letter dated March 12, 1965. See Appendix A.)
1967	Sailas Henry and another Ponapean sent to Malaysian Pepper Research Station, Sarawak, for 9 months of training.
1968	Ponape Producers Cooperative Association formed to market pepper and rice.
1969	1) Analysis made by Commodity Laboratories, Inc., of Ponape pepper which showed: NVEE (non-volatile ether extract) of 8.16%; and volatile oil content of 2.63 ml. per/100 gms.[2] The analysis showed that Ponape pepper exceeded the U.S. minimum standard for black pepper of 6.75% NVEE. 2) Former marketing strategy of selling pepper at tourist and small retail outlets was obviously not adequate to handle the hoped for yields of the '70's, which were projected to be as high as 136 tons for 1973. Potential wholesalers were contacted by mail and offered the 4 tons of pepper in stock at a "breakeven" price of 40¢/lb. F.O.B. Ponape, plus the opportunity to wholesale future harvests of Ponape's premium quality pepper.

1972	Pepper subsidy program ended due to government budget restrictions.
1973	1) A drop in world pepper prices resulted in about 10¢/lb. for unprocessed pepper for farmers on Ponape so output decreased sharply. (Mott, William, 1979.) 2) TT Economic Development Loan Fund made loans of up to $1500 available for farmers interested in planting up to 700 vines (1+ acre). By 1979, 10 to 15 loans had been made, and 15 to 20 loan applications pending.[3]
1976	Planting begun at a 20-acre government site in Palikir (Sokehs municipality). At maturity (1979) it was planned to lease sections of the site to Ponapean farmers. Establishment costs were figured to be $2,000 per acre exclusive of land costs, interest and overhead.[4]
1977	Pre-feasibility study done by Specialty Brands (Spice Islands) for a 500 to 1,500 acre pepper plantation. A follow-up study, jointly funded by the TT government and Spice Islands for $25,000 each, concluded that yield and growing conditions were among the best in the world. However, high labor costs and doubts about the availability of a dependable labor force caused Specialty Brands to decide against the project.
1979	1) Feasibility study of commercial pepper production potential in Ponape done for TTPI by Agland Investment Services, the same consultant who had done the Spice Islands study. 2) Proposal received from Jack Burgess to lease Palikir pepper plantation, expand it to 100 acres, then return it to the government 7 years later for lease to Ponapeans. Burgess' company would thereafter have first refusal on all future pepper produced at the site. The Ponape Foreign Investment Board rejected his request for an investment permit. 3) Palikir site subdivided and leased by the Public Lands Authority to several Ponapean farmers.
1980	Price per lb. for green pepper increased from 35¢ to 41¢ per lb.
1981	1) Ponape Producers Cooperative Association (PPCA) which had succeeded Micronesian Spice Association as a local marketing firm, found to have in excess of 3,000 lbs. of sub-standard 5 to 10 year old pepper stored. Citing financial irregularities and mismanagement, the State Attorney revoked PPCA's charter, leaving no local agent to market pepper. 2) Jurisdictional dispute between two government agencies, the Economic Development Authority (EDA) and the Conservation and Resource Surveillance Department (C&RS) resulted in the State Legislature mandating EDA by law as the government agency solely responsible for marketing pepper.
1982	At the request of the Chief Agriculturist the Public Lands Authority revoked three leases at the Palikir site because lessees were not fertilizing and cultivating properly, nor harvesting regularly.

1983 1) Height of the recent drought on Ponape.

2) A fire at the Palikir plantation, caused by drought conditions, destroyed remaining pepper vines.

3) Because of nonfeasance and personality conflicts, EDA Director's contract is not renewed. C&RS Director resigns from government service, purchases EDA's pepper stocks in order to export them himself to the U.S. as gourmet pepper.

II. PEPPER PRODUCTION, PROCESSING, STORAGE, AND MARKETING IN PONAPE

A. Production.

Factors that impact on pepper production are:

1. Growing conditions;
2. Land availability;
3. Site preparation;
4. Pepper diseases and pests;
5. Fertilization;
6. Labor availability;
7. Yield.

1. Growing Conditions. The combination of climate and growing conditions in Ponape are among the best in the world for pepper. As noted at the beginning of Section I, Ponape's soil, temperature range, annual rainfall, and consistent cloud cover are ideal. Pepper requires well-drained soils, or can become subject to root mold. Ponape's weathered, lateritic soil contains differing amounts of rock intermixed with it, which aids in drainage.

Although the good drainage results in healthier vines, the leaching effect of the high annual rainfall must be compensated for. Mott noted that the soil is particularly deficient in phosphorus, potassium, calcium and magnesium, and it must be treated with a heavy application of these nutrients before the initial planting. Regular fertilization schedules, based on plant maturity, must be maintained thereafter.

Since pepper on Ponape produces on a 12-month basis[5] because of regular rain, rather than seasonally as in monsoon countries like India, fertilization becomes especially important because bearing vines require heavier fertilization than non-fruiting ones.

It should also be noted that in many areas of the world, bright sunlight requires that pepper be intercropped with shade trees. This results in less available land per acre because of the space required for the trees. Since Ponape's cloud cover allows pepper to be planted in open fields, vines can be concentrated to about 700 per acre, and plantation farming is feasible.

When pepper grows on live trees, it must compete with its supporting host for soil nutrients. This, plus the concentration of vines allowed in open field planting, results in yields per acre 30% to 70% lower when pepper must be intercropped with shade trees. (Agland Investment Services, 1977)

The key to properly utilizing Ponape's growing condition, then, is regular and heavy fertilization. Without it, the heavy rainfall and excellent drainage eliminate soil nutrients, thus decreasing the heavy yield per acre made possible by intensive plantings in open fields.

2. Land availability. Ponape is an island of 129 square miles, less than half of which is suitable for agricultural use. The mountainous island interior rises as high as Mt. Ngihneni (2,595 ft.), although 11 peaks exceed 2,000 feet. Annual rainfall in the interior averages between 300-400 inches, and provides the source of the island's numerous streams and rivers. As a watershed for the island's water supply, much of the interior has been unofficially designated as a wilderness area by the State government, unsuitable for development or habitation.

About 52% of the land in Ponape has a greater than 20 degree slope. (Ponape Island Land Use Guide, 1979) Since steep slopes increase the chances of erosion and landslides (especially in heavy rains and in clay soils like Ponape's), development has concentrated along the more level areas of the island's perimeter.

Of the 48% of the land (62 sq. miles) with less than 20 degrees of slope, there are marsh, swamp, and flood plain areas that are only marginally suitable for agriculture. Although statistics have not been developed to show how many total acres are suitable for pepper, the 1977 and 1979 feasibility studies of Ponape's potential for pepper production identified 1500 acres in 4 sites as suitable for pepper farms. These sites are shown in Figures 1 and 2.[6]

Fertile land is underutilized in Ponape. The following maps (Figures 1 and 2) show available agricultural areas in Ponape, and land currently being farmed.

The exact number of farms and farmers in unknown, but almost all families can produce at least some of their own food. A family's farming may be limited to a breadfruit tree, a pig pen, and a few papayas, but even households in Kolonia can be considered as at least occasional farmers, for their own table use.

No statistics have been published by the State government on the number of "commercial" farmers, i.e., those who regularly sell produce.[7] However, the annual report for FY 82 for the Ponape Department of Conservation and Resource Surveillance showed the following:

1- 600 farmers used the Agriculture Revolving Fund;

2- 1,118 farm visits were made by extension agents;

3- assorted vegetable production marketed in Kolonia was 179,877 lbs. (In 1981, it was 113,792.)

A homestead program of former public lands had resulted in 693 deeds for small plots being awarded by the end of FY 1982. Evidence of agriculture development was a requirement for securing land title.

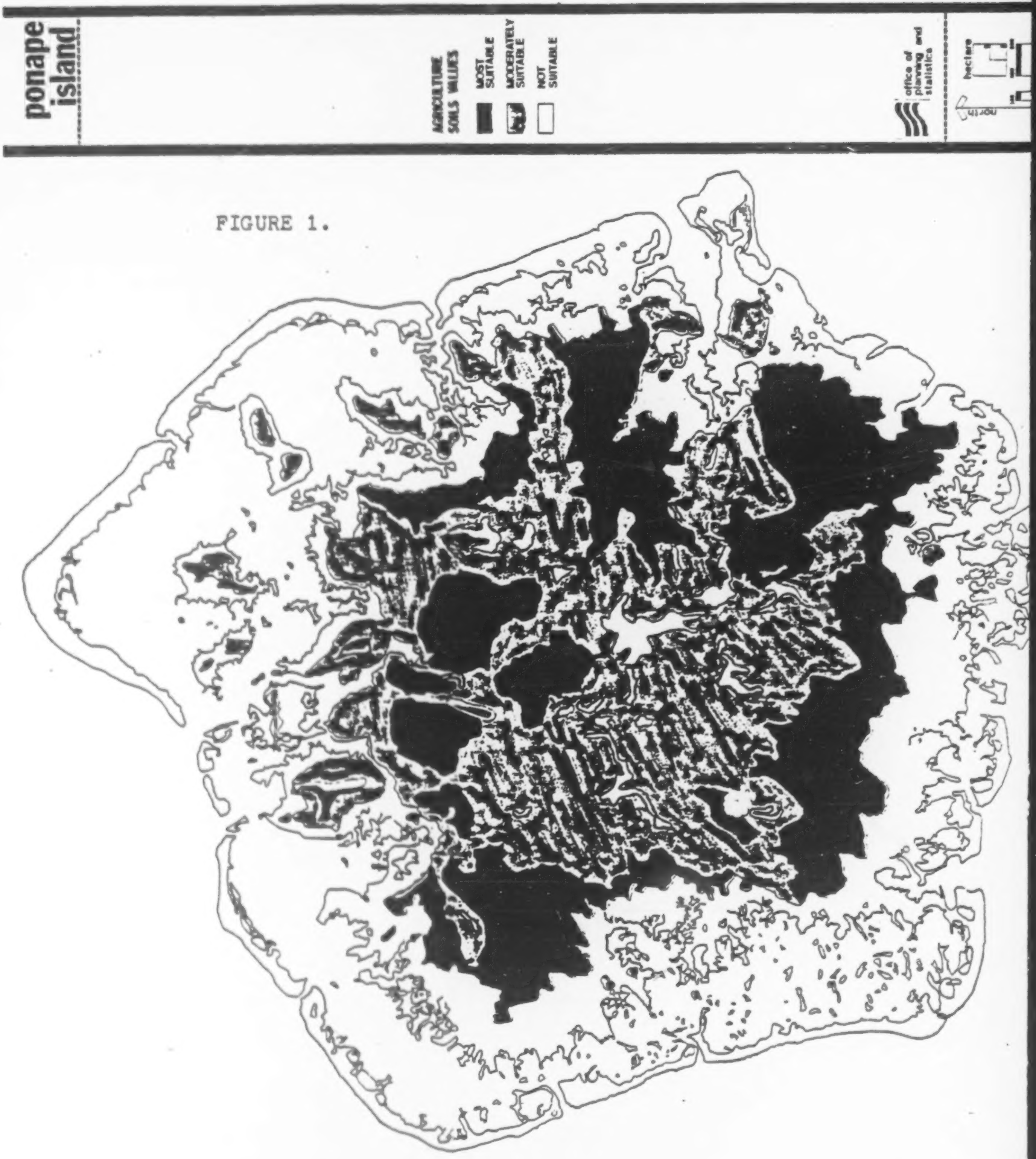
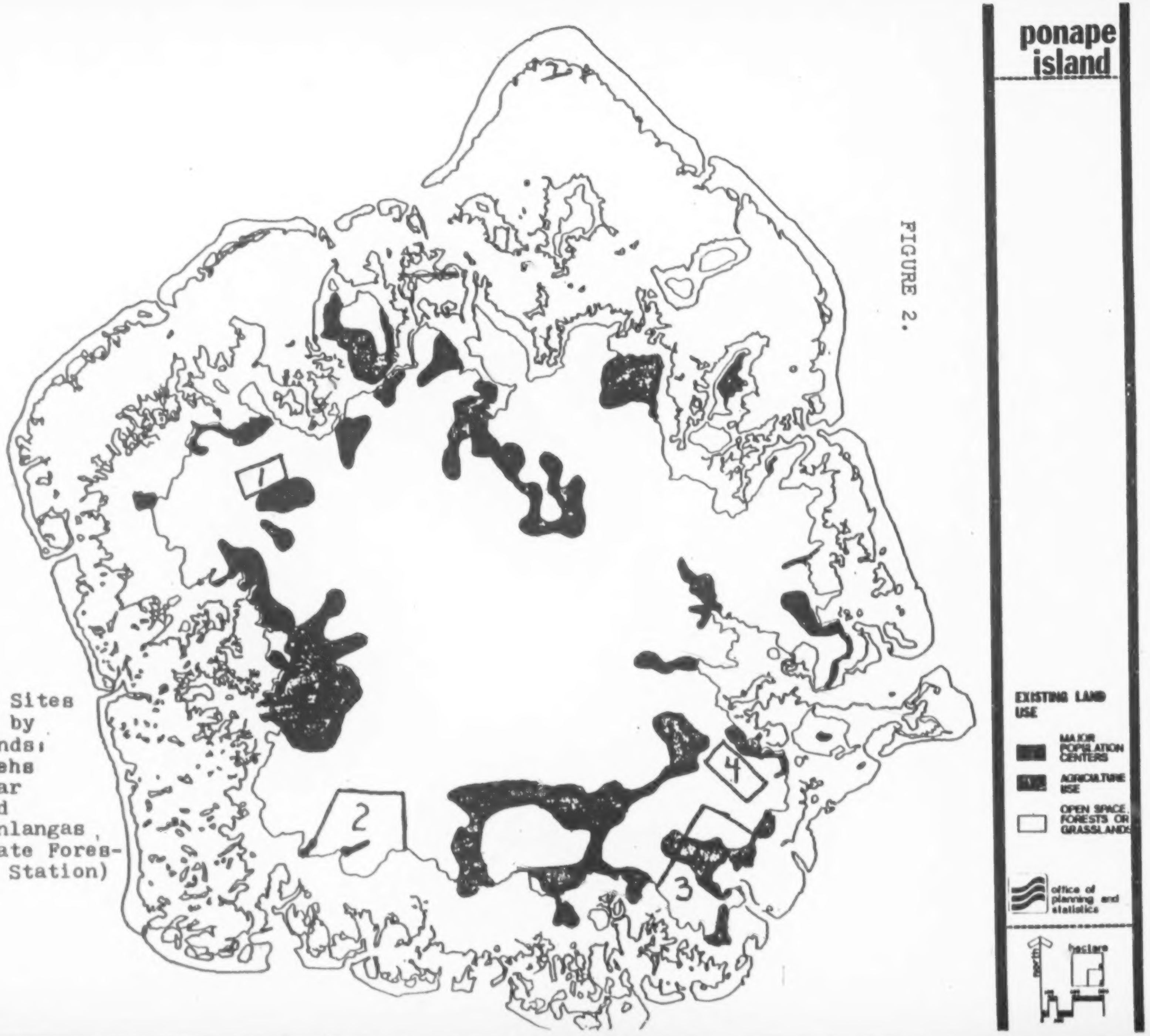


FIGURE 1.

ponape island
AGRICULTURE SOILS VALUES
MOST SUITABLE
MODERATELY SUITABLE
NOT SUITABLE
office of planning and statistics
north
hectare

FIGURE 2.


ponape island
EXISTING LAND USE
MAJOR POPULATION CENTERS
AGRICULTURE USE
OPEN SPACE FORESTS OR GRASSLANDS
office of planning and statistics
hectare
1
2
3
4

Plantation Sites
Identified by
Spice Islands:
1. Sokehs
2. Kipar
3. Lohd
4. Pohnlangas (State Forestry Station)

This patchwork of data suggests that there are numerous small landowners throughout Ponape, many of whom produce food for their own consumption, with surplus diverted in part to Kolonia markets, local hotels, restaurants, the hospital, and the school lunch program. Currently, however there is no large scale agricultural producer on Ponape.

Some large contiguous tracts of public and private land are available for farming on a commercial scale, however. These large underutilized tracts could be made available for plantation style development of pepper. Numerous small plots could also be used for pepper production.[8]

3. Site Preparation. All vegetation at planned farm sites must be removed, and sufficient fern posts cut for stakes for the pepper vines. Fern posts should be at least 10 ft. long, and not less than 4 inches across at the smallest end. Recommended spacing for the posts is 10'x6', which allows 10' avenues for tractors. However, vines can be placed as close as 8'x5'. Fern posts should go at least 2 feet below the soil surface.

Although the soil structure is very good for pepper, nutrients must be added before planting, at planting time, and at regular intervals thereafter. A soil analysis by William Mott resulted in his recommendation of a pre-planting application of limestone, superphosphate, muriate of potash, and zinc sulphate.[9]

Compost must also be added. Soil around fern posts should be mixed on a 1:1 ratio with compost in a 2 foot radius from the post, to a depth of 1 foot. (Zaiger, D., 1964.)

4. Pepper diseases and pests. No significant disease outbreaks have been reported in Ponape to date. Among the problems that can occur are root mold

(Phytophthora), which is generally associated with poor drainage. In India, where this can be a significant problem, 2 to 4 applications per year of Bordeaux mixture are used as a prophylactic. Two fungal problems, thread blight and leaf spot, can be controlled with copper fungicide spray. Of course, proper fertilization strengthens the vines' resistance to disease so regular fertilization should accompany any pesticides.

African land snails (Achatina fulica) are an agricultural pest throughout Micronesia, and the Agriculture Station has Ortho Snail and Slug Bait in stock for farmers with this problem. General insecticides such as malathion can be used to control any local insects who appear in pepper fields, but major insect pests which can be found in many pepper areas in southeast Asia, such as Longitarsus nigripennis and Laspeynesia hemidoxa, have not appeared in Ponape.

Good quarantine procedures are necessary to ensure that pepper diseases and pests from other pepper growing areas are not introduced into Ponape.

5. Fertilization. A detailed summary of fertilization needs on Ponape was described by William Mott in his 1979 Study. His suggested optimum fertilization schedule is:

1. at planting, 1/4 lb. of magnesium sulfate and 1/2 lb. ammonium sulfate per vine;
2. during growth but before maturity, each vine should have 1/2 lb. of 10-10-10 fertilizer every 4 months;
3. at maturity (after 3 years growth usually), fertilization is increased to 1 lb. 10-10-10 fertilizer per vine every 4 months, with supplements of 1/4 lb. magnesium sulfate per vine as determined by tissue analysis.

Costs to farmers for fertilization vary with the source of supply. Using lower cost sources of supply on the Asian mainland, in 1979 Mott projected fertilizer cost for the proposed pepper plantation at $378 to bring an acre into production over three years. (Mott, William, 1979.)[9]

6. Labor Availability. Should Ponapeans decide to increase pepper production, census figures show an adequate work force among the local population. The 1980 census shows an available work force of 8,010 of whom 3,830 work for wages either in government (2,120) or private business (1,710). The 4,180 remaining are either working at a subsistence level or unemployed.

For 1979, the year in which Mott completed the second feasibility study of pepper in Ponape, the average annual wage for a government worker in Ponape was $3,042. The average annual salary within the private sector was $1,065. (Hezel, Francis X., 1984) The lowest hourly rate paid government workers in 1979 (and until a 1982 cost of living increase of 20%) was about 80¢ per hour or about $6.40 per day. Because there was no minimum wage set by law, the private sector was unregulated in the salaries they paid. For his 1979 study, Mott assumed a $7/day wage for full time workers and a 6¢/lb. scale for temporary workers at harvest.

Mott's 1979 study projected a need for 275 to 300 full-time laborers if a plantation of 750 acres was attempted. For harvesting, 450 part-time employees would be needed. This labor requirement represents about 18% of the under/unemployed segment of the population. By contrast, the Spice Islands project of 1,500 acres would have required 2,500 full- and part-time local workers, according to a letter from the Specialty Brands President, dated June 13, 1977. This represents about 60% of the local available work force.

7. Yield. Yields per acre vary tremendously throughout the world, depending on fertilization, rainfall, pepper variety planted, plant maturity, disease, and other factors. Nations like Sri Lanka and India have relatively low yields per acre because they must plant pepper under shade trees, which reduces their ability to concentrate vines. Pepper is a seasonal crop in these monsoon areas also, unlike Sarawak. Since Sarawak is able to grow pepper in open fields, with vines concentrated to as many as 700 per acre, yields per acre in Sarawak are high. The range of yields per acre is illustrated in Table 1. (Spices Export Promotion Council, 1976)

Table 1. Representative Black Pepper Yields Per Acre of Major Pepper Growing Nations (Based on Production, Early 1970's)

LOCATION	YIELD/ACRE/YEAR	PLANT MATURITY
Malaya	660 lbs./acre	3 yr. old
Malaya	1,319 lbs./acre	5 - 7 yr. old
Sarawak	2,308 lbs./acre	3 yr. old
Sarawak	5,276 lbs./acre	10 yr. old
Sri Lanka	736 lbs./acre	average, all plants
Sumatra	379 lbs./acre	average, all plants
India	219 lbs./acre	average, all plants

Because these figures are averages, derived from the production of numerous farmers in these nations, variables such as fertilization and rainfall are not accounted for. However, the range of output illustrates how an acre can produce as little as a few hundred pounds of black pepper under marginal conditions, or as much as several thousand pounds under good conditions.

Ponape Agriculture Division figures show that pepper in Ponape, when planted 700 vines/acre, can yield the following:

Table 2. Pepper Yield in Ponape, Ideal Conditions[10]

PLANT MATURITY	FERTILIZER PER ACRE/YEAR	YIELD/ACRE/YEAR	YIELD/VINE/YEAR
1	1,050 lbs.	-	-
2	2,100 lbs.	-	-
3	4,200 lbs.	7,000 lbs. (green) 2,333 lbs. (black)	10 lbs. (green) 3.3 lbs. (black)
4	4,200 lbs.	10,500 lbs. (green) 4,666 lbs. (black)	15 lbs. (green) 6.6 lbs. (black)
5	4,200 lbs.	14,000 lbs. (green) 4,666 lbs. (black)	20 lbs. (green) 6.6 lbs. (black)

Little data is available about yield per acre of Ponape farmers, but available statistics show that Ponape farmers have not produced pepper at the high yields per acre which Ponape is capable of. Mott noted in his 1979 report that one of the best farms in Ponape in the late 70's was producing 3 to 4 lbs. of black pepper per vine (about 9 to 12 lbs. green pepper), but that improved farming techniques could have improved yield to 4 or 5 lbs. black pepper per vine.

Ponape Agriculture Division data for FY 1982 showed that 11.87 acres produced 20,428 lbs. of green pepper (6,809 lbs. black pepper). This can be translated into the following yields per acre and per vine.:

Table 3. Yield per acre and per vine, Ponape farmers, 1982[14]

	YIELD/ACRE	YIELD/VINE (650/ACRE)
green	1,720.97 lbs.	2.65 lbs.
black	573.6 lbs.	.88 lbs.

At the Agriculture Division's optimum production rate of 14,000 lbs. green pepper per acre per year (see Table 2), a well tended 680 vine (1 acre) plot should yield about 4,600 lbs. black pepper vs. the 573 lbs. actually produced. Even allowing for less intensive planting at 650 vines per acre, yield should be about 4,300 lbs. per acre per year.

Table 4. Comparison of Actual Pepper Production, 1982, to Maximum Possible Yield

	# OF ACRES	# OF* VINES	TOTAL LBS. (GREEN)	TOTAL LBS. (BLACK)
Actual Yield	11.87	7715	20,428	6,890
Maximum Yield (20 lbs. green/vine)	11.87	7715	154,300	51,433

(*The estimated number of vines has been reduced to 650/acre to allow for weak or dead vines, and fields not fully planted.)

The Ponape Agriculture Station yields of up to 4,666 lbs. per acre per year are comparable to the yield of mature pepper in Sarawak (see Table 1) where an acre produced 5,276 lbs. of black pepper in a year. The disparity between Agriculture Station yields and that of local farmers were discussed with Ponape Agriculture Division staff in 1982 and 1983, when they noted:[11]

- Fertilization was not done on schedule. Farmers tried to reduce their costs by not using fertilizer despite the availability of fertilizer at cost plus 10% at the Agriculture Station and a Revolving Loan Fund to help them finance purchases.
- If extension agents pruned new vines, farmers cooperated but farmers generally would not perform this task alone.
- Weeds were allowed to grow up between pepper vines, further draining soil of nutrients.
- Vines were not fully harvested and extension agents observed pepper rotting on the vine.

Available data on annual harvests in Ponape is shown below:[12]

Table 5. Ponape Pepper Production, 1966-1982

YEAR	DRY PEPPER OUTPUT
1966	2,500 lbs.
1967	5,000 lbs.
1968	no data available
1969	12,000 lbs.
1970	12,000 lbs.
1971	12,845 lbs.
1972	12,348 lbs.
1973	5,635 lbs.
1974	10,760 lbs.
1975	8,418 lbs.
1976	12,800 lbs.
1977	5,000 lbs.
1978	no data available
1979	no data available
1980	5,470 lbs.
1981	6,374 lbs.
1982	6,809 lbs.

The production data for 1971 in the 1972 Annual Report to the U.N. included the information that 42,000 pepper vines had been planted on Ponape. In the previous year's Annual Report, the Trust Territory government had noted that their program goal of getting 400 pepper farmers started in Ponape had been reached. Although the TTPI's goal had been for each farmer to have 200 vines (1/6 acre), the reported 42,000 vines equally divided among 400 farmers would have averaged only 105 vines per farmer. If planted 700 vines per acre, the 42,000 vines would have required 60 acres.

However, production data is not consistent with the number of vines. Only 10,000 vines were reported to be mature enough for harvest in 1971. The 12,845 lbs. of recorded production, if harvested from 10,000 vines, would result in a production rate of 1.28 lbs. black pepper per vine. The remaining 32,000 immature vines should have been mature enough for harvest no later than 1974. Even at the 1971 production rate of 1.28 lbs. black pepper per vine, the total of 42,000 vines should have yielded 53,760 lbs. of black pepper in

1974. The Annual Report for 1975 and succeeding years, however, shows that production did not exceeded 13,000 lbs. (See Table 5.)[13]

Although there is not enough data to show annual yield per acre in Ponape for every year since production began, it is apparent that farmers' yields are well below that of the Agriculture Station. Nonetheless, the potential yield per acre is among the highest in the world.

B. Pepper Processing, Packaging and Storage.

In Ponape, farmers harvest green and mature pepper, then bring it to the Agricultural Station for weighing and processing. Agricultural Division staff then partially dry the pepper and remove stems and debris. Next, the green pepper is scalded in hot water, moved onto screens, and then placed on racks in layers in a locally made hot air dryer that keeps the pepper at a temperature somewhat less than 135^{0}F. When the peppercorns are uniformly black, and have been reduced in weight by about 65%, processing is complete. Then two other department employees promptly package the pepper into heat-sealed polyethylene.

Mature berries that have ripened and turned red are processed into white pepper. After being separated from the green berries by Agricultural Station staff, the red berries are soaked in water for two to three days to soften the outer fleshy layer. The berries are then mechanically rubbed until the outer layer is removed. The remaining seed is then dried and packaged in the same manner as the black pepper.

This close control of the drying process by Agricultural Division staff and prompt packaging result in a uniform high quality. When pepper is produced in quantity in other areas of the world, some drying may be done by spreading it on the ground in the sun. This can result in insects, pebbles, grit, and other foreign material being combined with the pepper. This, plus the practice in some nations of warehousing it in bulk or large sacks, makes it vulnerable to insect and rodent damage as well as to a loss of freshness resulting from an evaporation of some of its volatile oils.

Since high quality is essential to successful marketing of Ponape pepper, the State government now provides both a subsidy and quality control to pepper production by supplying staff and equipment for processing at the Agricultural Station. Packaging materials are supplied by PPGA.

Storage of dried pepper remains somewhat haphazard, however, since there is no warehouse for pepper. It is sometimes stored at the Agricultural Station, sometimes in a building referred to as the Small Industries building, a former wood working shop. Both are functional as temporary facilities, but space is limited at both sites. If storage is required for more than 2 tons (approximately) these locations would be inadequate.

C. Marketing.

In 1977, Spice Islands felt that the world market conditions for pepper favored Ponape because of:

- increasing demand for pepper;
- static production;
- rising pepper prices; and
- the stringent quality controls imposed by the U.S. on pepper imports favored a hygienically processed and packaged pepper from Ponape for export to the U.S.

Both the Spice Islands study in 1977 and the 1979 study noted production problems in the 4 nations which supply about 95% of the world's pepper:

- Brazil is plagued by unsolved disease problems resulting in the average life of pepper vines being reduced to 6 to 9 years;
- India does not have significant amounts of additional land for pepper production, was experiencing disease control problems, and farmers were diversifying into cocoa, coffee and clove production;

- Sarawak has additional land available for pepper; but unless the world pepper prices remained at $1/lb. or more, the Sarawak farmers were expected to store their stocks until they could get a high enough price;
- Indonesia has land available for additional acreage, but production has been hurt by disease problems.

Other smaller producers may export all or most of their crop to a particular market, such as Malagasy pepper being sold exclusively in France because of favorable tariff advantages there.

Initially, however, pepper prices did not stay at the high levels projected by the 1977 and 1979 feasibility studies.

Table 6. Average Annual Price/Lb. for Black Lampong Pepper, New York Market, 1971-1983
(Source: 1984 Commodity Year Book)

YEAR	AVERAGE PRICE (U.S. ¢)
1971	51.3
1972	50.5
1973	57.4
1974	82.7
1975	89.8
1976	86.4
1977	115.7
1978	106.4
1979	106.3
1980	89.5
1981	84.7
1982	71.7
1983	71.9

But assessments by spice trade experts consistently projected a strong pepper market. Thomas Gonzales, a Los Angeles importer, when interviewed in 1977 said, "Pepper is in a good supply/demand position with demand stronger than supply.... A shortfall could really push the price up." John Fotchman, a New York importer, said "...they know we will buy pepper if it is $.50 or $2.00 per pound." (Agland Investment Services, 1977)

The predictions were accurate because as of April, 1985, the price for black Lampong pepper in the New York market had risen to $1.72 per pound. (Chemical Marketing Reporter, April 29, 1985)

As of 1983, PPGA was wholesaling black pepper locally at $1.80 per pound. So despite the predicted increase in world bulk prices for pepper, Ponape's wholesale price is still somewhat higher than market price, although the disparity has narrowed considerably.

However, the specialty market for pepper still seems to be the best target for Ponape pepper. A random sampling of the "gourmet" pepper retailing in the New York area showed the following price spread:

Table 7. Retail Prices, Gourmet Pepper, New York, 1985

BRAND	TYPE OF PEPPER	MARKETED AT	PRICE/LB.
Fauchon	mixed black, with Jamaican Pepper	$2.25/1.05 oz.	$34.29
Fauchon	Brazilian	$2.25/1.05 oz.	$34.29
Flavorbank	Szechwan	$1.60 for 5/8 oz.	$40.96
Flavorbank	Sarawak	$1.60 for 5/8 oz.	$40.96
Wagners	Malabar	$1.40/2.75 oz.	$ 8.14
Wagners	Lampong	$1.25/2.75 oz.	$ 7.27
Wagners	White	$1.65/2.75 oz.	$ 9.60
Bart	Brazilian	$3.95/3.53 oz.	$17.90

(Average retail: $24.18/lb.)

There are two pepper markets then--a gourmet market and a bulk pepper market. Because bulk pepper prices have been consistently below the wholesale price of Ponape pepper ($1.80 per pound), Ponape pepper has not been competitive on the bulk pepper markets. Its wholesale price is low enough, however, to keep it competitive in a gourmet market where retail prices are similar to those of Table 7.

If Ponape pepper is to be marketed principally as a gourmet item, a market analysis is necessary to determine what volume of gourmet pepper can be sold at what price levels with what attendant marketing costs.

And if improved production methods can be introduced, thereby reducing cost of production and substantially increasing volume, Ponape pepper might also be made competitive with that of other pepper producing nations. This would allow any inferior quality pepper produced on Ponape to be sold profitably on the bulk pepper market. Given the strong market that currently exists for bulk pepper, this seems feasible.

III. FACTORS INHIBITING PEPPER PRODUCTION ON PONAPE

There are three general areas where changes would have to be made before pepper production on Ponape could be improved. Some problems are environment related, others are economic maladjustments. However, by far the most serious handicaps are cultural.

A. Environmental and Physical Factors that have limited pepper production are:

1. easily leached soils;
2. limited roads;
3. limited communications;
4. recent drought conditions;

1. Easily Leached Soils. As mentioned in Section II, B, nutrients are easily and quickly lost from Ponape's soil. Poor soil results in lowered production and susceptability to disease, but heavy and regular fertilization adequately resolves this problem.

2. Roads. Roads in Ponape remain poor. Although Ponape's circumferential road has been completed, it is unpaved except in Kolonia. The dirt and coral roads of Micronesia are notoriously poor, and heavy rains result in impassable mud, ruts and potholes, and sometimes a mudslide or washout of road sections.

Asphalt or concrete paving have not been effective solutions. The asphalt pavement in Kolonia deteriorated rapidly and within months of the completion of work by Maeda Construction Co., road shoulders started to wash away and potholes started to appear. Since the Ponape State Government does not have either the expertise or funds to keep the roads in repair, extending the pavement beyond Kolonia is likely to result in just exchanging one set of problems for another.

Yet if undeveloped sections are to be turned into major agriculture areas, whether for pepper or other crops, an adequate produce transport system must be available. If heavily laden trucks must carry pepper or other produce over badly rutted roads to the Kolonia port, vehicle repairs are likely both to raise production costs and slow transport time. Although the condition of the present circumferential road does not preclude its use for transport of crops, other options might be more cost effective.

An alternative that could be investigated is barging produce into Kolonia. For several years, a locally built shallow draft barge has successfully transported lumber from southern mangrove forests into Kolonia. Since access to PATS was only by boat until the circumferential road was completed, the agricultural area near PATS has close access to a dock. And the Kipar site identified by Spice Islands is near the Ron Kitti harbor, so barge transport should be considered. Besides transport to Kolonia, farm roads are still needed on the southern side of the island. At the Sokehs site, the farm road system would probably need expansion.

3. Communications. Communications with Ponape remain difficult and expensive, which would be a negative factor for outside developers. A satellite receiving station was completed in 1983, which was a significant improvement, but antiquated, poorly maintained ground equipment still hampers telephone service.

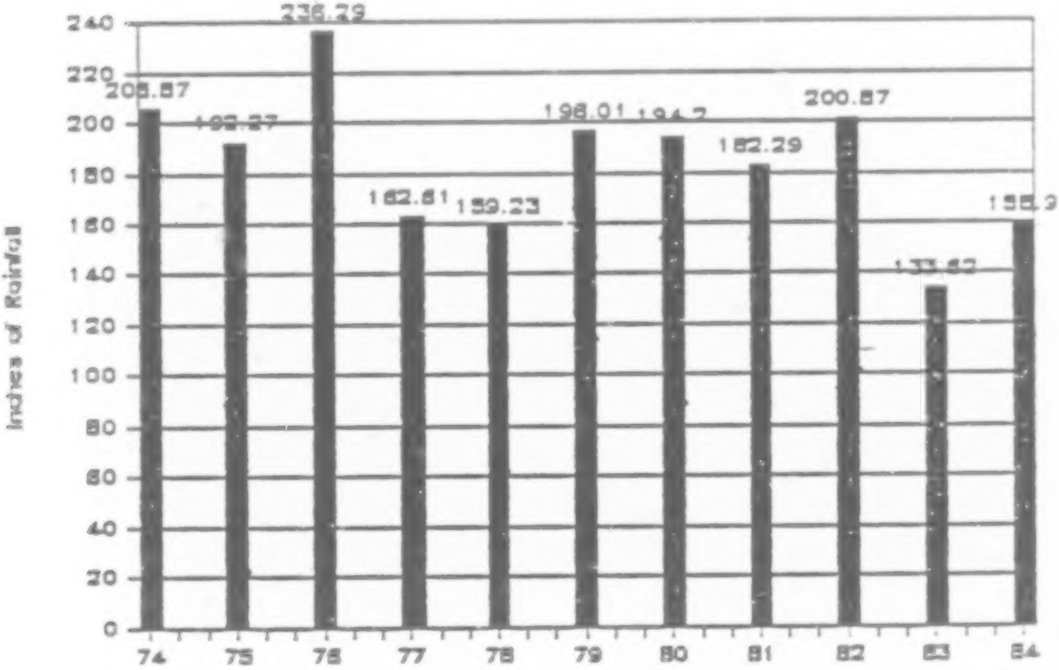
Telephones are available only in the immediate vicinity of Kolonia. The Falcam administration was beginning to collect information on short wave systems that would have allowed communications from Kolonia to other areas of the island, but communications remain a barrier to development.

4. Droughts and Typhoons. It is difficult to accurately gauge the impact of the recent drought on pepper, because pepper production data for 1983 and 1984 is not available. Since regular rainfall is necessary to keep vines fruiting, the prolonged dry weather had to reduce production, however.

As shown in Figure 3 below, rainfall in 1983 and 1984 was considerably lower than in previous years.

Figure 3. Annual Rainfall, Ponape Island, 1974-1984

(Source: National Oceanic and Atmospheric Administration, 1983 and 1984)



1983 and 1984 were the driest years since 1950, when U.S. climatological record keeping began. The driest period during the drought was between October, 1982, and June 1983, when rainfall was 80 inches less than normal. During this period, Agriculture Division staff estimated that in some areas as much as 70% of food crops died, including trees like breadfruit, mango, and coconut.[14] Brush and grass fires were a daily occurence during this period, and one such fire destroyed pepper vines at the Palikir plantation.

Pepper production seems to be recovering, however, if production data from 1982 and the first six months of 1985 are compared:

Table 8. Comparison of 1982 and 1985 Pepper Farms

YEAR	# OF PEPPER FARMERS	# OF ACRES PRODUCING	IMMATURE ACREAGE	TOTAL ACRES	# OF NEW VINES PLANTED
FY 82	55	11.87	8.31	20.18	1,329
1985	40	15	7	22	unavailable

As of the end of April, 1985, the Chief Agriculturist in Ponape estimated that pepper production for 1985 was about 2,000 lbs.[15]

Future frequent droughts are of low probability, given Ponape's pattern of regular high rainfall. In the event drought recurs, however, it is not likely to kill pepper vines. This conclusion is supported by the number of acres currently producing in Ponape, which had to have been planted no later than 1982 in order to be mature enough for harvest now. Prolonged drought would decrease yields, however.

Typhoons do not represent a significant weather problem. Typhoons begin to form around the area of the equator, and develop to typhoon strength as they move north and (usually) west. Since Ponape is less than 500 miles north of the equator, typhoons that affect areas like Guam, Saipan, Japan, Taiwan, the Phillipines, and the Asian mainland are usually well past Ponape before they have sufficient force to be dangerous. The National Oceanic and Atmospheric Administration has recorded only three typhoons on Ponape in this century -- in 1905, 1957, and 1958.

B. Economic and management problems limiting pepper expansion are:

1. high local wage levels;
2. lack of capable local management;
3. unpredictable supply, hampering marketing.

1. High Local Wages. According to data in the 1980 Annual Report to the U.N., the average salaried position in Ponape paid about $2,270 per year. Figures for the government sector are higher--$3,042 per year.

When compared to the 1985 World Almanac listing of per capita income of some of the other major pepper producers, such as

India	$150 per capita in 1977;
Brazil	$1,523 per capita in 1978;
Indonesia	$560 per capita in 1982;

labor expense is considerably higher in Ponape than in rival producing nations.

In many development analyses of Micronesia, high labor costs are one of the factors most frequently mentioned as inhibiting Micronesian economic development.

2. Lack of Local Management. Currently, there is no Ponapean citizen working on Ponape who is trained and experienced in large scale agrobusiness administration. Although certainly there are educated Ponapeans qualified to handle aspects of large scale pepper development, it is my opinion that none of the businessmen and government officials who have been involved with pepper on Ponape can draw on the combination of education and experience necessary to

plan, finance, initiate, and manage this complex enterprise of plantation style pepper farming.

There are Ponapeans who have worked with pepper farms and farmers, and who know how to set up small pepper farms. Some of the individuals who were with the Trust Territory pepper project during its inception in the 1960's remain in active government service, although pepper is no longer their major area of work or expertise. Some local business people have marketed small quantities of pepper outside Ponape with varying success. There is a local pepper growers' cooperative, PPGA, which has been run by Ponapeans as have other cooperatives such as PPGA and the Micronesian Spice Association. Despite their increasing experience with pepper, with business mamagement, and with international marketing, however, Ponapeans have not yet had management experience in international agrobusiness to combine with their local experience.

Marketing internationally is a complex, competitive undertaking which requires skills that intelligence and a business degree do not entirely supply. The fact that to date no Ponapean or group of Ponapeans has successfully developed pepper on a commercial scale, either at the plantation level or in marketing, lends support to the explananation that they have not yet acquired the necessary combination of skills and experience to do so.

It should also be noted that the Ponapeans with relevant backgrounds who have been involved with pepper are either successful businessmen or governmen employees, or both. If any of them were to try to develop a commercial scale pepper production and marketing business, a complex and time-consuming project under the best of circumstances, it is likely that their previous committments to jobs and/or businesses would handicap their ability to allocate adequate time, attention, and energy to pepper.

3. Unpredictable Supply. The reputation of Ponape pepper has spread within Micronesia, to Hawaii, and into the U.S. It has been sold in all those areas, and vendors have reported to the Ponape Conservation and Resource Surveillance Department that sales are "good". The problem with selling pepper, however has been dependability of supply.

As statistics show, recorded annual production has varied considerably over the years, with recorded production since 1977 not exceeding 7,000 lbs. This small a quantity has not interested a major distributor like Specialty Brands, and the inability to guarantee minimum quantities for regular shipments has discouraged smaller importers.

Although the Economic Development Authority (EDA) was designated by State law as the agency to market pepper, it has not done so. So the current situation is that there is neither a demonstrated marketing capability nor an adequate, dependable quantity of pepper which can be contracted to spice importing firms.

C. Cultural dysfunctions are by far the most significant source of problems inhibiting pepper production on Ponape. They are:

1. the absence of a strong work ethic;
2. a transitional economy, still largely subsistence, but moving towards a cash economy;
3. the Ponapean family system;
4. traditional/subsistence farming vs. cash crops;
5. fear of land alienation.

1. Work Ethic. The lack of a work ethic was cited by the President of Specialty Brands as the deciding factor against establishing a Spice Islands

pepper plantation in Ponape. In a November 28, 1977, letter to the Trust Territory High Commissioner he wrote: "...we have concluded that it is extremely unlikely that there exists on Ponape a sufficient pool of motivated, work-oriented citizens to man a project the size we have contemplated. In fact, we have reluctantly concluded that the only feasible method of staffing this project is with foreign labor (Filipinos, Koreans, etc.) This would require an enormous increase in investment.... We do believe that under the proper circumstance, and on a somewhat smaller scale, it is possible to produce pepper on Ponape."

In previous generations, a strong work ethic was not necessary in the subsistence economy of an island as productive as Ponape, where diet staples like coconut, taro, breadfruit and bananas flourish. However as times change, aspects of the traditional culture have become dysfunctional and the lack of dependability of a labor force in Ponape now inhibits economic development.

It should also be kept in mind that foreign labor is used elsewhere in Micronesia. Saipan, with a smaller population than Ponape, utilizes thousands of non-resident workers annually, with many of them in low-skill, low-salaried jobs such as construction, maid service, or restaurant/bar service. This, despite a recently estimated unemployment rate in Saipan of as much as 9%. In Guam, the governor was empowered (in 1984) to expedite foreign worker entry permits because of the labor demand in Guam that the local resident population did not fill.

Availability of a dependable labor force is a requirement for development anywhere. In Guam and in Saipan, foreign labor is being imported with resultant social problems and a loss of a portion of the foreign workers' wages back to their country of origin. Ponape has not yet resolved how enough dependable labor can be matched to requirements for development.

2. Largely Subsistence Lifestyle. Ponape, like much of the rest of the TTPI, is in transition from a traditional subsistence economy towards a modern cash economy. About half its population of 22,319 (1980 Census) are under 16 and therefore not part of the labor pool. Most of the wages (70%) are earned by the approximately 2,120 government employees, who represent less than 10% of the population. Obviously, many people must make a living outside the cash economy.

An excellent short article on transitional Pacific economies is "Traditional Economic Systems and their Response to Westernization," by Henry Schwalbenberg, in the Micronesia Seminar publication Past Achievements Future Possibilities. In it, he outlines some differences between production and investment patterns in traditional vs. cash economies.

The basic equation of a properly functioning subsistence economy is

PRODUCTION = DEMAND

and the basic unit of both production and consumption is the family. To oversimplify, a family produces what it needs and no more. In a traditional economy, then, the family unit is able to "produce all that they can consume of the basic staples and provide a level of clothing and housing acceptable by their traditional standards, at the cost of no more (and sometimes less) than three or four male labor hours a day."

Cash in Micronesia is often used to buy items such as kerosene, food, clothing or fabric for clothing, building materials, alcohol or cigarettes. Most of the family's needs for food and shelter, however, can be generated from the land and surrounding ocean. Many families, then, have little cash and limited items to spend it on.

In a sort of chicken and egg situation, this is part of the reason why there is a limited range of consumer goods on Ponape. Although the number, price, and quality of products have increased somewhat in recent years, another factor limiting the need for cash is the difficulty in obtaining a variety of consumer goods on the island.

A pattern that a number of farmers follow is to produce just enough cash crops to meet their immediate cash needs. If they wish to purchase beer or food for a feast, rice for their family, if they need gas for an outboard motor (not necessarily theirs--borrowing is common) so they can go fishing, or if they decide on some other special expenditure, they will bring in crops to Kolonia to sell. If they do not have an immediate use for the cash, they might throw crops like breadfruit, cabbage, etc., to pigs rather than market the produce.

This occurs with pepper as well. Agriculture Division staff, as noted elsewhere in this report, have not been able to convince farmers to always fully harvest their pepper vines. Had the farmers thought it important enough to convert their pepper into cash, undoubtedly they would have.

One conclusion to be drawn from this is that pepper production even from existing pepper farms could be improved. This is supported by a comparison of the yield per unit of the Ponapean farmer vs. that of the Agriculture Station, as shown in Tables 2 and 3 of this report.

Schwalbenberg's article outlines another closely related conclusion, which is "Household production in traditional Pacific societies is generally characterized by...an under-utilization of available resources."

3. Family/Clan System. Those more used to living within a cash economy may legitimately wonder why a Ponapean would not want to have as much cash as possible, even without an immediate need for it. Although his house might not be electrified, thus eliminating a need for major appliances, a Ponapean could improve his material quality of life with any number of products. Besides

that, money in the bank would provide a resource in time of illness, old age, emergency, natural disaster, or would even afford him the simple indulgence of occasional impulse buying. Ponapeans generally, however, are not motivated by these considerations as are Americans.

There is a very specific deterrent to saving--the Ponapean family. Lifestyles are still closely linked with extended family in Ponape, and "borrowing" is a common activity. Those that have are supposed to share with those who have less, particularly within their family and clan. For someone with savings, this means having to deal with regular requests from family and/or friends who can think of ways to spend his money for him.

What this means is that those who work hard and earn more than they spend are asked to contribute to the lifestyle of less industrious relatives, to make large contributions to the endless succession of island funerals, to "lend" money with little likelihood of repayment in cash if indeed repayment is ever made, or to undertake similar unproductive expenditures.

Even if this extra wealth is translated into consumer goods like a pickup truck or a boat with an outboard, the owner is often asked for the temporary use of this property. A larger house means that more relatives will expect to be able to stay there and be fed at the owner's expense for periods varying from a few days to semi-permanent residence.

This is exasperating, irritating, and more than a bit bewildering for an American observer. It is also a source of exasperation to the Ponapean who has to deal with the problem, and although more and more Ponapeans within the wage sector of the economy complain about this, saying "no" remains extraordinarily difficult and clearly contrary to custom.

Although some individuals have managed to amass personal capital and have used it to start a local business, the requests for donations and financial assistance is never ending and stressful. The Ponapean cultural background of sharing wealth is undoubtedly one of the major handicaps to economic development in Ponape today, because it removes much of the incentive for the farmer (or businessman or government worker) to increase his earnings beyond his immediate ability to consume.

4. Subsistence/Traditional Farming vs. Cash Crops. Agricultural production in Ponape can be characterized as subsistence, traditional, or cash crop farming.

The first category needs little explanation. It consists of food like taro, breadfruit, coconut, and bananas, which are diet staples and are grown primarily for personal consumption.

The second category is dominated by sakau (Piper methysticum) and yams (Dioscorea). Both are significant in the traditional culture of Ponape and are valued beyond their food value or cash equivalent.

The roots of the sakau shrub are washed, coarsely chopped, stone pounded to a pulp, then mixed with water on a large flat "sakau stone." The result, a viscous muddy liquid with anesthetic properties is an essential part of traditional ceremonies. It is also used less formally as an evening beverage within a family or community group.

Many families, even within the urban center of Kolonia, have their own "sakau stones" and make sakau as often as several times a week. "Sakau bars" have grown up in recent years both in Kolonia and outer areas, where people can buy a cup or a pitcher of sakau much as they would buy a Budweiser in a bar.

Sakau varies in its potency according to its age and growing conditions. It is one of the traditional gifts offered to nanmwharkis and nanikens, the highest ranking traditional leaders. It is a matter of considerable honor and prestige to produce high quality sakau for a public occasion.

Interestingly, sakau's traditional value has also created a place for it in the cash economy. Although sakau has been exchanged for cash for years, the increasing popularity of sakau bars in Kolonia resulted in the appearance of sakau as a regular item in the Kolonia Public Market in about 1981. By 1983, a mature sakau plant was selling for $20 to $30 in Kolonia, with demand frequently exceeding supply, according to Public Market vendors.

Giant yams, whose size is measured by the number of men needed to carry them (as "2-man yam" or "5-man yam") are also a part of traditional Ponapean life. Farmers who can produce an especially large yam for a ceremonial occasion, such as a feast honoring traditional leaders, can add to their social standing or even the likelihood of their being awarded a traditional title as a consequence of the gift. Since locations of yam patches are often concealed so that trespassers do not try to steal the valued yam, areas suitable for farming other crops can be left supposedly fallow, while they are actually camouflage for yams.

Although small yams can be purchased along with other cash crops at Kolonia markets, giant yams are reserved for traditional use only.

Cash crops, the third category of production, are any fruits and vegetables produced in excess of family needs and sold, usually in Kolonia. Chinese and head cabbage, eggplant, green onions, green peppers, bananas, breadfruit, papayas, mangoes, coconuts--these and other varieties appear with varying regularity in Kolonia stores. Additionally, the school lunch program, the hospital, and local restaurants provide a regular outlet for crops. Pepper, of course, falls in this group.

Although the three categories together do not exhaust available land, fully employ the population, or fill the demand of stores in Kolonia, the supply does not increase to meet the demand. Again, the overriding reasons relate to the primarily subsistence nature of the economy, with characteristic underproduction. When the needs of the production unit, the family, are met then production stops.

Farmers in Ponape, then, do not have a history of maximizing production. Subsistence production takes care of most of the family's food. Some traditional crops contribute to social standing and prestige, which is very important in Ponape. Some cash crops bring in enough money to purchase a few imported goods. So farmers with a subsistence/traditional/cash crop production mixture may not have much incentive to increase cash crop production such as pepper, even though both land and labor may be underutilized.

5. Fear of Land Alienation. The alienation of land, either by sale or lease to non-Ponapeans, is only reluctantly and occasionally allowed. Land ownership is culturally very significant and few non-Ponapeans have been able to secure long-term use of land on the island.

The Village Hotel near Awak, in Uh municipality, opened in 1976 but land lease problems have plagued the American couple who own the hotel since its inception. The Etscheits, a family of Belgian descent who purchased land during the German administration of Micronesia, have on-going problems with the traditional leadership of Net municipality over their holdings, despite the fact that they have lived in Ponape for four generations. Even the transfer of land in Palikir to the FSM for the national capital was delayed for years because of reluctance to allow even the national government to control Ponapean land.

Any development project, including a pepper plantation, that turned the use of large land areas over to non-Ponapeans would probably meet considerable local opposition, no matter what economic benefits accrued. However, Ponapean equity participation in a development project, so that the business was seen as at least partly Ponapean, would probably make access to land easier to negotiate.

IV. ECONOMIC IMPACT OF PEPPER IN PONAPE

Analyses of export/import levels and Gross Island Product are available in various plans from both the TT and FSM Planning and Statistics. However, simpler perspective from which to assess pepper's impact on Ponape is to look at some basic data. Of most significance is the fact that since 1977, no production statistics available show a total output of black pepper in excess of 7,000 lbs. per year.

In 1982, the wholesale pepper price set by PPGA for whole black pepper was $1.80 per pound, and the 6,809 lbs. recorded production for that year would have been wholesaled at $12,256. That year, farmers harvested 20,428 lbs. of green pepper and would have been paid 41¢ per pound, or $8,375 directly. The difference between the $8,375 in direct payments to farmers and the $12,256 revenues from wholesale prices would have been the revenue of PPGA, the pepper growers' coop.

Shown below is a comparison of actual income from pepper sales by farmers to the income possible from the same acreage at maximum yield. (See Table 4 for derivation of maximum yield.)

Table 9. Comparison of 1982 Actual Pepper Farm Revenues to Revenue from Maximum Yield

	# of Acres	Total Yield (Black Pepper)	Payments to Farmers	Payments to PPGA
Actual Production & Revenue	11.87	6,809 lbs.	$ 8,375	$12,256
At Maximum Yield per Acre	11.87	51,433 lbs.	$63,263	$92,579

Agriculture Division records for 1982 showed 55 pepper farmers, although an unknown number of these had farms with immature vines. The average direct payment to the 55 farmers in 1982, then, was $152. Had the 11.87 acres been at maximum yield, those farmers could have realized an average payment of $1,150 each.

The average amount of land per farmer in 1982 was .22 acres, and the average number of vines per farmer was about 140. With these resources capable of generating (at maximum yield) $1,150 per year, a farmer could approach salary levels for unskilled government workers (Laborer, Ponape State Government, pay level 2, at $1,780 per year in 1982).

A consistent complaint of farmers in Ponape to Agriculture Division staff has been that they receive too little per pound for their pepper. In an effort to encourage production and in response to pepper farmer's complaints, the price per pound for green pepper was increased from 35¢ to 41¢ in the early 1980's.

Output for 1981 and 1982 increased by an average of 1,100 lbs. black pepper per year over the total output in 1980. Although the price increase may have contributed somewhat to the increase in production, there are too many other variables to determine the exact degree of correlation. However, the price increase was clearly not sufficient motivation for farmers to bring production anywhere near the maximum yields possible, shown in Table 9.

This is consistent with an unpublished statistical analysis of production data of copra, another Micronesian cash crop, done in 1982 by Henry Schwalbenberg. His analysis showed that there was no effective correlation between price increases and production increases in copra. Instead, there was greater consistent correlation of copra output to population and available land.

Since cost of production for pepper in Ponape is already considerably beyond that of other pepper producing nations, further price increases to

INTENTIONAL
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stimulate production are of questionable value. If additional revenues would motivate local farmers, they have but to improve their husbandry to significantly improve their yield, and thereby their revenue.

Financial prospects for the marketing of pepper, however, are somewhat brighter. In 1983, there were an estimated 12 to 15 businesses in Ponape where pepper was retailed. They were mostly handicraft outlets, but some grocery stores and two restaurants sold pepper to tourists. Some of these vendors also shipped pepper to Guam, Saipan, Hawaii and the mainland U.S. where it was generally sold in conjunction with island handicrafts.

Also in 1983, a local business person purchased approximately 6,000 pounds of pepper from EDA. Unconfirmed sources reported that he reached agreement with Neiman Marcus for them to purchase his stock, but the sales agreement was terminated in 1984 when his shipments were found to include an unacceptable level of debris such as pebbles and stems mixed with the pepper.

Although prices are not available for any of the large sales made to off-island purchasers, to which volume discounts would probably have been applied, a 3 oz. package of pepper would retail on Ponape for about $2.00, or $1.50 per ounce. No data was available to show how much pepper was retailed on Ponape to visiting tourists, and how much was sent off-island to be retailed elsewhere. Some guestimates can be made about the average price per pound paid to pepper marketers, however, and bracketed within a reasonable range to show income potentials. For this comparison, maximum price per pound is set at $1.50/oz. and minimum at half that. The resultant projection (Table 10, below) shows possible income for Ponape pepper marketers for 7,000 lbs., for 51,000 lbs. (maximum yield for 1982 pepper acreage as per Table 4), and for 25,500 lbs. (half maximum yield for 1982 pepper acreage).

Table 10. Revenue Projections for Retail and Off-Island Pepper Sales

Pepper in Lbs.	($12/lb.) @ $.75/oz.	($16/lb.) @ $1/oz.	($24/lb.) @ $1.50/oz.
7,000	$ 84,000	$ 112,000	$ 168,000
25,500	306,000	408,000	612,000
51,000	612,000	816,000	1,224,000

This bracketed price range is consistent with the random sample of gourmet pepper prices in Table 7, which ranged from a low of $7.27 per pound to a hign of $40.96 per pound, at an average price of $24.18 per pound.

The marketers on Ponape would have paid PPGA $1.80 per pound, so wholesale cost for 7,000 pounds of pepper would be $12,600. Less the wholesale cost of the pepper, the 15 retailers of record in 1983 would have averaged revenues ranging from $4,760, to $6,626, to $10,360, depending on whether their average resale price was $.75/oz., $1/oz., or $1.50/oz. Obviously, revenue projections at higher production levels are considerably increased.

The conclusions to be drawn about Ponape's pepper industry are:

1. With the low yield per acre and with total annual output never exceeding 13,000 lbs., pepper has never been produced efficiently nor near capacity on Ponape.
2. Pepper farmers realize a minimum return from pepper production because of poor farming techniques.
3. Retailing pepper on Ponape and reselling it to off-island retailers has better revenue potential than growing pepper.
4. If government workers involved with pepper are discounted, less than 100 Ponapeans currently receive income as a result of pepper production and marketing.

V. ENVIRONMENTAL IMPACT

The current low levels of pepper production have little environmental impact. If pepper production was expanded to plantation size farms, the following environmental concerns would have to be considered:

A. Impact on tree ferns (Cyathea negricans). Since this species is used to provide supports for pepper vines, consideration of a replanting program should accompany any plantation plans. Discussions in 1983 with the State Forester and his staff revealed that they did not have the technical expertise for a tree fern replanting program. Outside technical assistance, then, would be necessary for such a replanting program.

A volumetric survey of Ponape's tree species was scheduled by the U.S. Forest Service in 1983, but was not available for my research. This report might well furnish additional useful information about quantity and location of tree ferns. The appendix of Mott's 1979 Feasibility Study on pepper includes an approximation of the tree fern population in a section of Madolenihmw, near a possible plantation site.

B. Avoidance of flood plains and watersheds. Any agricultural project would have to consider this environmental aspect. Since pepper does not produce as well at higher altitudes, it is not a good crop for the watershed areas identified in Ponape's mountainous interior. However, any planting in flood plains, where heavy rainfall could produce flooding and runoff, would result both in erosion of top soil and silting of the lagoon, with possible reef and aquatic species damage.

3. Endangered species. An avifauna survey was also scheduled by U.S. Forest Service personnel for 1983. If this has been completed, it would show habitats and current populations for endangered and threatened species such as

the Ponape dusky white eye (Zosterops cinerea), the short eared owl (Asio flammeus) and fruit bat (Pteropus molassina). Although the Ponape lory (Trichoglossus rubiginosus) is not a threatened species, it does exist only on Ponape so its population levels and habitats should also be considered in any large scale plantation planning.

D. Fertilizers and Pesticides. An analysis of fertilizer and pesticide accumulation and runoff effects should be included in any feasibility study for a plantation, whether for pepper or other crops. It is likely that data for Ponape on ground water, on sources of drinking water, location of flood plains, drainage areas, on the flow of lagoon currents, on soil structure and permeability, and other relevant subjects is incomplete. Previous relevant studies of Ponape should be compiled, reviewed, information gaps indentified, and necessary supplemental data developed. A consultant agency or individual can then prepare an analysis of the environmental impact of the use of pesticides and fertilizers by a commercial scale plantation on Ponape.

VI. OPTIONS TO IMPROVE PEPPER PRODUCTION IN PONAPE

Pepper development in Ponape can take two different roads.

A. The first option is to try to expand the number of small, locally owned farms, to increase acreage, and improve yields. Since the FSM Development Bank has reportedly set aside $100,000 for loans to pepper farmers in 1985, financial assistance is not immediately needed. However, management and marketing technical assistance are necessary. A well planned program using Peace Corps, USAID, UN volunteers, or other international assistance agencies might be able to provide the expertise needed to motivate and organize more farmers to produce more pepper.

Supplemental training programs could be conducted through Ponape Agriculture and Trades School (PATS), Adult Education, and the College of Micronesia in order to teach more people effective pepper farming practices.

A permanent, dependable marketing agency or business would have to be set up, along with a processing facility able to handle pepper in volume, and a warehouse for storage. If pepper production could be increased from small farmers, capital for a processing facility could probably be generated locally, either by government appropriation or through the Development Bank.

All of the above should be specifically addressed in an Action Plan for pepper development that itemizes:

- what kinds of technical assistance will be necessary, and at what point in the project;
- sources of the technical assistance;
- a projected total program cost to expand pepper production;
- an itemized breakdown of start up and annual costs;
- projected revenues from all sources, including pepper sales, government appropriations, grants-in-aid, loans, etc.
- a marketing plan, based on a professional market analysis.

Lastly, a project manager will be necessary to implement the Action Plan, to coordinate technical and financial assistance, implement the marketing plan, oversee the construction of commercial size processing and warehousing facilities, and respond to the many unforeseen adjustments, changes, and problems that will occur.

B. The second option is to initiate plantation style farming, probably of several large tracts in different sections of the island. This would allow the plantation to draw its labor from different communities on the island, generally removed from Kolonia. Local financing might be available through the Development Bank, through commercial banks, or a combination of these. Experienced management would be essential, and this is not available locally. A joint venture would be the best way to structure control, combining the local expertise of Ponapeans with the management and marketing strengths of a U.S. firm experienced in international agrobusiness.

Acreage and employees would be increased gradually to optimum size, and efforts would be made to recruit the labor force locally wherever possible. The corporation would have to be able to import non-resident workers for positions that could not be filled locally, however. The target market would be the U.S., emphasizing high priced "gourmet" sales.

However, if an American firm established a plantation style pepper farm on Ponape, that firm would undoubtedly control the marketing of Ponape pepper. Since the incidental production of Ponapean farmers would probably have to be sold to this agrobusiness, the price paid to Ponapean farmers might drop from the 41¢ they currently receive.

As an illustration, Specialty Brands offered to buy green pepper from local farmers at 20% of the New York price for black pepper. Even the current high price of $1.72 per pound for black pepper in New York would give Ponapean farmers only 34¢ per pound for green pepper, using this formula. This kind of price cut to local producers would quite likely result in complaints from farmers and opposition from Ponapean elected officials.

However, the Specialty Brands formula was based on bulk pepper prices. If increased quantities of Ponape pepper can be marketed as a gourmet item, acceptable price levels to farmers might be possible. An updated feasibility study would be needed though, to determine how a plantation would impact on local farmers.

From an economic and functional perspective, the plantation system is more feasible, more likely to increase local jobs, provide increased taxes (on salaries), to generate a significant amount of export, and generally stimulate Ponape's economy. It is also likely to result in lower public costs, and more appropriately experienced project managers.

The small farm system has not been successful in the almost 25 years that it has been tried, and the problems are not due to inadequate information or the lack of supplies or equipment, or even lack of capital. Given the cultural constraints of Ponape, the small farm system is not likely to make a dramatic improvement even if infusions of technical and/or financial assistance were provided.

VII. RECOMMENDATIONS FOR U.S. CONGRESSIONAL ACTION

The U.S. Congress can reasonably expect to have a relatively minor influence on pepper production in Ponape. Their ability to help is limited to funding projects and/or technical assistance. The hard work of turning the pepper industry around must be done in Ponape, by Ponapeans, with some outside technical assistance. The Congress can encourage Ponapean policy makers to make some necessary decisions, however.

Since it is clear that previous efforts to develop Ponape's pepper producing potential have not been successful, policy makers in Ponape need to:

1. review the problems of the program to date;
2. be aware of the range of options open to Ponape;
3. see the social, economic, and political implications of each option;
4. have a current pepper market analysis, which includes the "gourmet" sub-market;
5. have an updated feasibility analysis of plantation style development, which includes any public costs (such as for roads, or use of public facilities) and economic benefits (such as income taxes, sales taxes, etc.)
6. and likewise, have a cost/benefit analysis of the small farm development option.

Presenting this information could be accomplished in a local Pepper Development Conference, whose purpose would be to generate an Action Plan for an increase of pepper production to targeted levels by specific dates, and choosing either the plantation or small farm model.

Ponape decision makers should be approached about their willingness to participate in this Conference. If legislative and administrative leaders are supportive, they should designate a local government agency to co-sponsor the Conference with OTIA or USDA, or whichever U.S. agency is designated as the U.S. agency co-sponsor.

The Ponapean co-sponsoring agency would make local conference arrangements. The U.S. co-sponsor would contract with appropriate experts to provide the economic information of items #4, #5, and #6 (above), and would select a team of development planning experts to lead the conference. The cost of providing the necessary analysis, and the planning consultants would probably range from a minimum of $100,000 to as much as $250,000, depending on the consultants chosen and their fees.

The Action Plan resulting from the conference would be prepared by the consultants, using participants' input, and reviewed either by key Ponapean leaders or by a Task Force selected by Ponape officials for this purpose. The final draft would be available to both U.S. and Ponapean policy makers.

Thereafter, a qualified individual could be made available to the Ponape State Government either through Peace Corps, USAID, other international assistance agency, or by private consulting contract, to be Project Manager and begin the implementation of the Action Plan. The U.S. Congress would commit this project management technical assistance until the completion of the Action Plan. The costs for implementation of the Action Plan cannot be estimated until the Action Plan is formulated.

This locally based type of planning has been tried recently in Micronesia with some success. The TTPI Juvenile Justice Planning program has generated Action Plans for juveniles which have received both community praise and active support. Micronesia Seminar recently completed an economic development conference in Ponape, and published the results. A lagoon use plan was completed for Saipan in 1984, using consultants from Guam, which would be an excellent planning model to follow. Lastly, the Saipan Chamber of Commerce is in the process of completing a business development plan for that community which was put together by local businessmen.

Unfortunately, there are no quick and easy solutions to the problems of development of Micronesia. The stops and starts, the one step forward then two steps back pattern of change can be discouraging. But even in Micronesia, if accurate information is combined with careful, detailed planning and competent, patient management, achievement will come and realistic objectives can be reached.

FOOTNOTES

1. Although the limited source of cuttings has not, to my knowledge, reduced the yield or strength of pepper vines in Ponape, there should be on-going experiments with other pepper varieties, especially the high-yielding Panniyur variety developed in India.

2. The initial analysis is included in Appendix B, among the selected correspondence to and from Spice Islands. It was an enclosure with Kikuo Apis' letter of November 10, 1969. The pepper analysis itself is dated September 3, 1969. Mott had another analysis done for his 1979 report and it showed a non-volatile ether extract (NVEE) ranging from 7.04 to 7.25 for Ponape's black pepper. His discussion of the analysis results are available in Appendix C, pp. 52-54.

3. All EDLF records for loans made in Ponape were turned over to the FSM Development Bank in 1982. Most EDLF loans were delinquent for extended periods, so it is possible that some of these pepper loans are still active.

4. A breakdown of costs, supplies, equipment and labor per acre is found in the TTPI Government publication, "Black Pepper, An Investment Opportunity in Ponape District," (1976) on p. 6, Table II. It is the likely source for Mott's identical figure on p. 14 of his 1979 study.

5. The peak harvest period for pepper is November through January, inclusive.

6. A public land use plan was developed by the Falcam administration in 1982. To the best of my knowledge, it has not been used by the current administration, but it would provide more information on land available for development in the public sector.

7. Data on numbers of farms and farmers could probably be developed from files at the Agriculture Station on Ponape, but it was not available for this report.

8. Records of land titles are available through the Land Commission on Ponape.

9. For a schedule of fertilization costs on a yearly basis for the proposed plantation, see page 102 of Mott's 1979 Study. The Study is included as Appendix C of this report.

10. The Agland Investment Services Study of 1977 is the source of the data in Table 2. However, the Study does not specify what type of fertilizer or what fertilization schedule was used.

11. In 1983, there were 5 extension agents who made farm visits. All had been with the Agricultural Division for more than 8 years because all were listed at either step 6 or 7 of their pay grade in the October, 1981, Ponape State Personnel Listing. They would have advanced one step for each year that they performed satisfactorily at their grade level. Since they probably started in lower level jobs than extension agent and were promoted (extension agent was not usually an entry level job), each probably had between ten and twenty years experience with the Agricultural Division. Although I do not currently have access to their personnel files, I doubt that any were high school graduates. This is not unusual, however, especially for Ponapeans over 40 as these men are. Their training was conducted on the job by the Chief Agriculturalist who in 1983 was an American citizen with a Ph.D. in Agriculture.
    The Chief Agriculturalist's response to poor production was to make access to the farmer's revolving loan fund as easy as possible, and to offer fertilizer as partial payment for harvested pepper. The latter effort was largely unsuccessful, he reported. He also tried to locate additional farmers to put in pepper vines and to help them find funds to get started, but in his discussions with me in 1982 about the situation, he believed that farmers were reluctant to invest effort and money and then have to wait 3 years before being able to harvest.
    The manager of the Bank of Hawaii branch in Ponape from 1979 to 1983 confirmed in an April 20, 1985, conversation with my research assistant on Saipan that Bank of Hawaii had no restrictions on agricultural loans, that he could have made loans for pepper farm start-up costs, but he received no applications for loans for pepper during the 4 years that he managed the Ponape bank. During that time, the usury law limited loan interest rates to 12%.

12. Most of this data was derived from the Annual Report to the U.N., except for the data for 1977 which came from Mott's 1979 report (p. 15). The data for 1980 through 1983 was taken from the Summary Report of the Activities of the Department of Conservation and Resource Surveillance from March 1980, to April, 1983. Data for 1983 and 1984 was unavailable.

13. Whether the statistics of the 1972 Annual Report to the U.N. were erroneous, or whether yield per acre became very low, I am unable to determine without access to records in Ponape.

14. The Govenor instructed the Agriculture Division to estimate the amount of damage to farming as a result of the drought in late 1982. After extension agents visited sites on Ponape and nearby lagoon islands, the agents reported that in the hardest hit areas up to 70% of crops died from lack of water. Although shallow-rooted crops could be expected to tolerate drought poorly, ground water was sufficiently reduced that some of the tree crops died as well. I believe that a written report on the effects of the drought was sent to the High Commissioner by the Governor's Office.

15. The data for 1985 in Table 8 and for estimated pepper production came from an April 19, 1985, telephone call to the current Chief Agriculturalist, Ponape State Government, from my research assistant in Saipan. This is the only information about pepper that I was able to obtain from sources on Ponape.

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Background Paper No. 5

ASSESSMENT OF LIVESTOCK PRODUCTION TECHNOLOGIES IN MICRONESIA AND FEASIBILITY STUDY FOR LOCALLY PRODUCED PIG FEED ON PONAPE

by

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ABSTRACT

The natural environment of the Micronesian islands in the Federated States of Micronesia, the Republic of the Marshall Islands and the Republic of Palau are not suitable for animal feed production, based on grain crops, in adequate amounts, since there is little arable land; and grain crop yields are low, therefore production costs are high. On account of this, intensive livestock production is at a low level, using mostly costly imported feed. It should be emphasized, however, that Micronesians are striving for self-sufficiency in livestock production. At present, large amounts of frozen meat, mostly broiler chicken, and canned fish are imported from overseas, replacing, to an extent, the traditional protein source of fresh fish. Local pigs, chickens and some goats are freely roaming in the villages of Ponape, occasionally fed with food leftovers. They inflict substantial damage to root crops and constitute human health hazards through their scattered droppings.

Swine hold an important position in Micronesia, especially on Ponape, since they are always slaughtered at funerals, feasts and celebrations. The estimated number of pigs in Micronesia is about 20,000-30,000, of which about two-thirds are on Ponape. Only about 10 percent of pigs are kept in confinement on Ponape, since imported feed is expensive and often not available. Pig feed produced from local raw materials is possible; however, at the present time it is not feasible economically without government assistance, although if established, many additional benefits would accrue, including the reduction of the trade deficits in the region.

Broiler chickens are only occasionally raised, due to high production costs and large amounts of low-priced imported frozen chicken, the value of which amounts close to an estimated $4 million. Drastic measures have to be taken, such as import duties on frozen chicken and canned fish, and establishment of fish processing plants, to improve the economy in general, reduce the trade deficit and make broiler production worthwhile.

Egg production is insignificant and satisfies only partially the limited demand in district centers. The nutritional value of eggs would warrant a more widespread consumption, but at present, low demand, high production costs, inadequate extension service, limited knowledge of the required technology and management practices prohibits a more widespread production, although with government help it could become acceptably profitable. As a first step, import duties should be levied on eggs dumped on the island markets.

Goats contribute very little to the diet of Micronesians at the present time, since goat meat is only marginally accepted in the culture, in spite of its palatable taste. The great potential of goats as meat producers lies in their ability to use the abundant forages available as their exclusive feed at a very low cost. Recently, the United Nations Development Program (UNDP), in conjunction with the Food & Agriculture Organization (FAO), launched a widespread campaign to promote and develop goat production in the region. It is hoped that, through vigorous continuation of the program, in time goat production will substantially enhance the Micronesian economy.

ASSESSMENT OF LIVESTOCK PRODUCTION TECHNOLOGY IN MICRONESIA

INTRODUCTION

For centuries, the Micronesian people depended on fish, the only significant natural resource of the region, as their main supplier of protein. Today this is true only for the many small coral islands scattered in the Pacific. On the main islands of Micronesia, especially in the district centers (state capitals), imported canned fish and imported frozen chicken take priority over fresh lagoon fish. The climate and topography of the islands are not suitable for animal feed production based on grain crops, since there is little arable land, and grain crop yields are relatively low and, therefore, production costs are high. Pigs, chickens and some goats are usually roaming freely on the land, often damaging crops.

It is well known that the Micronesian people have largely substituted fresh fish with imported canned fish and frozen chicken as their main protein source. The diet of Micronesians, especially the young, is overwhelmingly of carbohydrate origin; therefore, for health reasons, increasing protein-rich food sources is desirable. For the economic development of the islands, it is essential that they become self-sufficient in food and reduce imports. Eggs and goat meat are excellent protein sources and, in my opinion, could in time have an important role in achieving self-sufficiency.

Pigs are by far the most significant livestock and have great cultural importance: they are always slaughtered at feasts, important family occasions, in honor of traditional leaders, and in large numbers at funerals, where often hundreds of people gather. Chickens are around all homes and provide occasional meat for guests or sick members of the family. Egg producers are rare, having unit sizes from 500 to 2,000 layers kept in cages and are fed with commercial feed. The main reason pigs are not raised intensively in enclosures is because of the difficulty of producing feed from local raw materials at a profitable price. Feed production costs may even increase, due to increasing labor costs, since high government wages reduce the incentive to work on the land. Commercial feed is imported in limited amounts at relatively high prices.

Goats are relatively rare, mainly because goat meat is only marginally accepted in the Micronesian culture. Recently, a long-term development program was launched throughout Micronesia by the United Nations to determine whether goat meat and milk could be successfully produced. It is hoped that, if widely accepted, it will reduce the need for imported meat and animal feed.

Also note that, in spite of the common belief that goats can destroy or damage native vegetation, improved goat husbandry using exclusively controlled feeding can eliminate the hazard. The economic advantages of keeping goats is obvious, considering that goats kept in confinement can be fed with abundantly available grass and herbage at no cost, whereas pigs kept in confinement have to be fed to a great extent with expensive commercial feed.

At present, beef cattle are raised on Palau and Ponape only. Ranch-type raising of cattle is not possible due to small landholdings and, in some instances, difficult land terrain. Experience in Palau shows that at least three to five acres of natural grassland is needed for each animal. Establishment of improved pastures has proven to be uneconomical, due to high input of fertilizers required to establish and maintain the pastures.

According to a state agriculture survey in 1983-84, a total of 97 cattle were raised in the Federated States of Micronesia. A 1983 livestock census shows that on Palau the number was 62. There were no cattle on the Marshall Islands according to the 1982 FAO Yearbook. The existing cattle are grazing.

A cow-calf type of operation utilizing dairy breeds on a ring and rope situation would be more appropriate. Such an operation would provide milk (which incidentally is little used by Micronesians) and meat from locally available green forage.

Carabao (swamp buffalo) are rare and are used mainly for draft. The limited number of livestock kept in enclosures render only insignificant amounts of manure for fertilization purposes; nevertheless, it is productively used in small vegetable gardens.

There were 130 carabao on the Federated States of Micronesia islands in 1983-84 (state agriculture survey), 16 on Palau, and none on the Marshall Islands (1982 FAO Yearbook). Carabao are used by some families living at outlying places to transport such items as building material, a bag of rice from the store, etc. The number of carabao is so small that use trends cannot be determined.

In this study, covering the Federated States of Micronesia, the Republic of the Marshall Islands and-the Republic of Palau, the following livestock production technologies and their economic significance will be discussed: swine, broiler chickens, layer chickens, and goats.

A map of Micronesia, land area and population data are attached (Figure 1; Table 1), including representative data on the climate. Production and trade statistics are sketchy and unreliable; hence only rough estimates are used in the study. Planning livestock development in detail will be possible as soon as comprehensive statistics are available.

SWINE

In Micronesia, swine hold an exceptional position, since they are a focal point of cultural gatherings, feasts and funerals; however, pork is not a part of the regular Micronesian diet. About 90 percent of the estimated 27,000 pigs are village free-roaming animals, of which about 12,000 are raised on Ponape.[1]

At present, laws confining pigs are enforced only in the Republic of Palau and the states of Yap and Kosrae in the Federated States of Micronesia. Free-roaming pigs are only occasionally fed with food leftovers. Micronesian pigs were introduced to the islands several hundred years ago and show strong resemblance to their wild ancestors. Through the years, a number of popular breeds were introduced, changing slowly the characteristics of the local pigs for the better. Recently the Ponape State Division of Agriculture has acquired purebred boars and, using artificial insemination techniques, promotes the upgrading of the local stock. Pigs kept enclosed are mostly fed with imported commercial feed. The price of imported feed is high; hence the number of pigs kept in confinement is small, especially on Ponape. If the imported pig feed could be replaced by feed produced from local raw materials (root crops and fruit crops) at a reasonable price, it could benefit farmers, increase employment opportunities and reduce the trade deficit.

The possibility of producing pig feed from local raw materials is discussed later in detail under "Feasibility Study for Locally Produced Pig Feed on Ponape." Even with the relatively high price of imported feed, raising pigs on Ponape as a commercial venture may be profitable if proper management practices are applied. At the Ponape Agriculture and Trade School, about 100 pigs are raised annually on imported feed with profitable results. The 1984 estimated cost for a 200-pound pig was $1.13/lb. live weight. The market price varies from $1.35/lb. and $1.75/lb. live weight, depending on the immediate demand (e.g., a large funeral), resulting in an acceptable profit.

In Micronesia, especially on Ponape, pigs of all sizes are transported live to feasts or funerals by the participants. Pigs may be slaughtered at such occasions only in the presence of the "nahnmwarki" (district king), or village chief. After they are slaughtered, all are roasted in a so-called

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[1] Livestock statistics in Micronesia are unreliable, especially for pigs. Table 2 provides a guideline.

"uhmw", an improvised oven, using stones heated in a large fire. The roasted pigs are cut in various sizes and distributed to the participants present according to their social standing and titles. Often 50-100 pigs are slaughtered on such occasions.

This practice eliminates about 90 percent of the pigs otherwise to be slaughtered in a slaughterhouse. A subsidized slaughterhouse would enable farmers raising pigs in confinement on imported or locally produced feed to sell their pigs at the most profitable stage of the growing period and provide acceptable cut meat for the market, reducing the amount of imported meat. It would also provide opportunity and example for other farmers to raise pigs commercially. In time, such a slaughterhouse may become profitable.

Commercial pig production is further hampered by the lack of adequate slaughtering and refrigeration facilities on the islands. In the main towns, demand for fresh pork from expatriate communities, hotels and restaurants, though small, is there, which unfortunately is not exploited. A slaughtering facility would meet this demand and encourage the farmers to sell pigs in excess of the requirements for funerals, feasts, etc. to the central slaughtering facility. It could produce, although only in small amounts, bone and blood meal, using appropriate technology, reducing the imported amount of protein supplement needed for producing animal feed from local raw materials. The facility would need to be run by the government or heavily subsidized as the throughput of animals to the slaughter facility would be so small that it would be uneconomical for anyone to run it privately.

BROILER CHICKENS

Today imported frozen chickens are extremely popular on Ponape and on other Micronesian islands, especially in district centers replacing, to a large extent, fresh fish--the traditional protein source. The retail price of imported frozen broiler chickens varies between $0.90 and $1.10 per pound, compared to the price of fresh lagoon fish at $0.75 to $0.85 per pound, canned mackerel at $0.96 per pound, and fresh tuna at $1.00 per pound.[2]

In Micronesia, there is no commercial broiler chicken production, except for occasional experiments, due to high production costs. At the Ponape Agriculture and Trade School, for example, a few hundred broilers have been raised annually since 1976 but, because of the high production costs, they are raised only for demonstrative purposes. Usually 200-500 one-day-old chicks are imported from a Hawaiian hatchery, raised for 8-10 weeks and then slaughtered at four pounds live weight to supplement the diet of the students. At the present time, the cost per processed weight, excluding processing costs (the students do the processing), is $0.96/lb. Taking into account processing costs and reasonable profit margin, the sales price to stores would be $1.30-$1.50/lb. (Table 3), prohibitively high to compete with imported frozen chicken and fish.

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[2] Prices were assembled by the author and are generally applicable to Micronesia.

The volume of imported frozen chicken on Ponape is estimated at 350 tons per year.[3] Assuming an estimated population of 25,000, it is equivalent to about 28 pounds consumption per person per year, compared to the U.S. consumption of about 43 pounds. Assuming the same 28 pounds consumption per person per year for the whole region with a population of 136,000 (U.N. estimate for 1984), the annual import is about 3,800,000 pounds, amounting close to a $4 million strain on the Micronesian economy.[4] The total volume was valued at $1.00/lb. The number of broiler chickens consumed, using three pounds average weight per bird, is about 1.25 million per year.

In the foreseeable future, there is little hope to establish a broiler industry in Micronesia, since there are no locally available raw materials for producing the exacting feed requirements, and the price of imported commercial feed of $0.21-$0.24/lb. is prohibitive compared to the U.S. price of $0.08-$0.10/lb. The high Micronesian price is the result of the U.S. price plus transportation costs. The low U.S. feed price and the efficiency of the large-scale U.S. broiler industry contribute to the low cost of the imported frozen broiler chickens and inhibit the local production. Only drastic measures could reduce the large volume of imported frozen and canned meat and give a chance for local broiler production.

Such measures should include: (1) imposing an import duty on frozen chicken and canned fish; and (2) establishing fish processing plants at district centers. The results of these measures would greatly improve the entire Micronesian economy and reduce the large trade deficit.

The economic feasibility of a fish processing plant should be viewed as a means to reduce the large trade deficit of Micronesia, partially caused by large amounts of imported cheap canned fish and frozen chicken. The raw material for canneries is available in the two million square miles of ocean surrounding Micronesia.

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[3] The volume of imported frozen chicken was estimated by PATS in 1978, by surveying major stores on Ponape, to provide statistical material for the Agri-Industrial Bulletin #3 (Szentkiralyi, 1976).

[4] The $4 million annual import of frozen chicken was estimated by using the per capita consumption on Ponape and projecting it for the whole population of Micronesia (Table 1).

The problem of establishing canneries is price competition, since locally produced canned fish obviously cannot compete with imported U.S. or Japanese products. The answer may be import restrictions or price supports or both. The benefits, in addition to fiscal ones, would be a chance for the Micronesian people to process their own natural resources and become self-sufficient in marine products. The technical details of such a plant are outside the author's competence.

LAYER CHICKENS

Chickens roaming freely around Micronesian homes occasionally provide meat for the family; the eggs are haphazardly hatched by the hens and none are used for human consumption since eggs are not a customary part of the Micronesian diet. Commercially produced eggs are available only at district centers in small quantities, mainly to partially satisfy the need of foreign residents and tourists. The egg producers are using imported one-day-old chicks from Hawaii and are feeding them exclusively on imported commercial feed. On Ponape, the amount of imported pullet grower feed and layer feed varies between 50 to 100 tons per year, sufficient to raise and maintain 1,000-2,000 layers per year, producing 20,000-40,000 dozen eggs. This is true, more or less, for all Micronesia. At the Ponape Agriculture and Trade School, about 8,000 dozen eggs are produced annually. The cost is $1.30/dozen. The retail price in Kolonia, the district center and capital of the Federated States of Micronesia, varies between $1.50 and $1.80 per dozen; hence a limited amount of egg production is profitable.

The nutritional value of eggs would warrant a more widespread consumption and demand. The prerequisite for a gradual improvement in this respect is government assistance to increase production, whereby a reasonable consumer price would increase demand and still ensure profit for the producer. An import duty should be levied on eggs 'dumped' on the islands; a volume estimated at about 70,000 dozen for the Federated States of Micronesia alone.

GOATS

At the present time, there are only about 1,500 goats in Micronesia (the Federated States of Micronesia, Marshall Islands, and Palau). The main reasons for the low number is that goat meat is only marginally acceptable in the culture. In general, goats may not be used for ceremonial purposes, and pigs on the other hand are very rarely slaughtered for ordinary use; hence goats may become the source of a better diet. Goats are indiscriminate browsers and the local people have no knowledge of goat management.

To increase the supply of animal protein for the growing population of the Pacific islands, to reduce imports of meat, meat products and animal feed and thereby improve their trade balance and free funds needed for economic and social development, the United Nations Development Program currently provides assistance to promote and develop goat production in the region. Goat production was selected by the UNDP as an obvious target in view of the ability of goats to thrive well under the prevailing conditions and their efficiency of production on the locally available browse, producing high quality meat and, eventually, milk. A further advantage of goat production is its suitable size for semi-subsistence tree crop small holdings--small 2-5 acre agricultural holdings, where tree crops (coconut, breadfruit), fruit and root crops (bananas, yams, etc.) are simultaneously grown, the products of which are in excess of the subsistence level--and its ability to thrive well in island environments on bush and weed grazing.

The immediate objectives of the UNDP are: (1) to introduce a limited number of Anglo-Nubian breeding bucks to upgrade the small-sized Micronesian goats; (2) to make an assessment of improved goat husbandry under managed conditions in relationship with the vegetation, human food and environmental protection aspects of the island; (3) to improve animal health services required to develop the production of existing stocks of goats; and (4) to strengthen the capability to maintain and improve livestock production programs through the training of local staff. The program is also involved in establishing production units where there were no goats before, selection from existing stock appropriate nucleus herds, planning appropriate goat sheds for stock accommodation and management, and organization of goat management trials on tethering, paddock grazing, and exclusively indoor feeding.

The Ponape Agriculture and Trade School is participating in the training program and has established production and trial units, totaling about 20 goats. It is hoped that, through vigorous continuation of the program, in time goat production will substantially contribute to the economy of Micronesia.

Further diversification of livestock production in Micronesia could be enhanced by promoting duck production, which is at a very low level on the islands, and possibly introducing new species, like geese and rabbits. Ducks would need additional commercial feed, since suitable locations for aquaculture ponds are scarce, and snails are hardly found. The feed conversion ratio for ducks is higher than for chickens; hence they need more feed per unit of production. To my knowledge, geese and rabbits were never introduced to Micronesia and their acceptance and feasibility would have to be investigated. Also, the current stock of village fowl could be improved by cross-breeding with some hardy, meat type variety.

RESEARCH AND EXTENSION SERVICE

The technologies for producing pork and poultry products used in Hawaii, Guam and the other islands of the Pacific are transferable to conditions in Micronesia, and thus there is little need to spend the limited funds the islands have to do their own research unless outside agencies are willing to do it for them. Research is, however, required in determining the processing and storage costs of locally produced root and fruit crops which could be used for feeding non-ruminant livestock.

Extension of production technologies carried out by the Agriculture Division of each of the islands is extremely poor due to lack of trained staff and poor overall supervision. Simple leaflets in local languages on production techniques could be very useful to improve livestock production at both subsistence and commercial levels.

GENERAL SUMMARY AND CONCLUSIONS

Summarizing the assessment of livestock production technologies in Micronesia, the following problems are apparent:

(1) Livestock production, although very important for the Micronesian economy, is at a low level, although Micronesians are striving for self-sufficiency.

(2) A major obstacle to improvement is the lack of commercial feed produced from locally available raw materials. This is especially true for pig feed, since pigs are the most significant livestock. The environment of Micronesia is well suited to produce root and fruit crops which may provide basic raw materials for local feed production, but at the present production levels and technology, the price of these raw materials is so high that the ensuing feed cost cannot compete with the imported feed cost.

(3) There is a great demand for broiler chickens, but production is negligible since production cannot compete with low-priced imported frozen chicken.

(4) Other livestock products, such as eggs or goat meat, are not commonly consumed, primarily because imported canned fish and frozen chicken are easily obtainable at low cost.

(5) Feed processing and slaughtering technologies are prone to suffer under diseconomies of scale due to the common management of free roaming animals, small human population and markets for locally produced meat or eggs restricted to expatriates, and tourist trade, attributable to low local demand

for such relatively expensive items.

Solutions to these problems may be grouped in the following two potential action categories:

(1) Government intervention regulating the volume/price of imported livestock and fish products to thereby allow the development of local livestock production.

(2) Promotion of farmer education, research on the cost of processing and storage of locally produced root and fruit crops, improvement of extension services and marketing.

Such actions could produce many opportunities for the Micronesian economy. In time, it would change a primarily consumer-oriented society depending on foreign aid into a producing society using the available foreign aid for further development.

FEASIBILITY STUDY FOR LOCALLY PRODUCED PIG FEED ON PONAPE[5]

INTRODUCTION

Pigs hold an important position in the Ponapean culture, since they are slaughtered at feasts, funerals and celebrations. The estimated number of pigs on Ponape is 15,000, or about 600 per 1,000 population, compared to about 200 per 1,000 population in the United States.[6] Almost all (90-95 percent) of the pigs are village free-roaming animals and are only occasionally fed with food leftovers, some root crops, bananas, breadfruit or coconut meat. This practice inflicts substantial damage to crops and constitutes human health hazards from contaminated drinking water and flies thriving on scattered manure droppings. In spite of efforts to confine pigs in cages, little progress is made due to the lack of adequate, reasonably priced pig feed. The Ponapeans are very strong in observing their traditions, and their lifestyle is expected to continue prominently in the local economic development program.

At present, the amount of imported commercial pig feed is about 400 tons per year, costing $168,000, sufficient to feed approximately 1,000 pigs.[7] Local production of this feed would:

(1) provide additional income to farmers producing the raw materials;
(2) provide job opportunities;
(3) have pig feed easily available at a lower price;
(4) eliminate the uncertainties of long distance transportation of imported feed; and
(5) reduce the outflow of money.

DESCRIPTION OF POTENTIAL FEED SOURCES AND RATION

In this study, dried banana meal, dried cassava root meal and copra meal are considered energy sources. The required protein supplement shall be provided by imported fish meal. A simple and suitable swine ration composed of locally-produced materials could be:

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[5] This entire section was derived from the author's extensive research on the subject. Information and statistics from sources listed under "Literature Cited" were used to a great extent. The research was augmented by in-depth personal interviews with the following experts: Catalino Sam, Manager, Ponape Coconut Products; Haresh T. Patel, Animal Production Officer, FAO/UNDP; William Raynor, Agronomist at PATS; managers of farmer markets and stores in Kolonia, Ponape State.

[6] The estimated number of pigs per 1,000 population on Ponape is based on an average of 15,000 pigs and 25,000 population. In the United States, it is based on 52 million pigs (Swine Report, Hawaii Cooperative Extension Service, July 1985) and 230 million population.

[7] Commercial pig feed requirement per pig is based on an average of 2.25 pounds feed consumption per day (Ponape State Division of Agriculture).

Banana, dried	40%
Cassava root, dried	30%
Copra meal, expeller method	15%
Fish meal, commercial	15%
TOTAL	100%

The advantage of using these raw materials is that, with the exception of fish meal, they are successfully produced on Ponape. A favorable prospect to produce fish meal exists, since the surrounding sea is teeming with fish.

1. Dried Banana Meal

The fresh whole banana (with the peel) contains about 20 percent dry matter. Dried banana contains about 88 percent dry matter (Table 4). The green fruit can be dried readily in the sun, or by mechanical means employing supplemental heat. Ripe bananas are more difficult to dry, but are more palatable than green ones. The dried banana slices are ground to form the meal. It constitutes a good source of carbohydrate for pigs during all phases of the production cycle, although it appears from performance studies that the amount of metabolizable energy is lower in banana meal than in corn. Dried green banana meal can supply up to 50 percent of the diet of pigs. On plantations, bananas may yield an average of about 3,000 pounds of fruit per acre. As of now, the yield on Ponape is 13,000-15,000 pounds per acre.

Bananas may be planted under coconut trees and would not require additional tilled land. On commercial plantations, fertilizers are necessary, especially potassium.

2. Sweet Cassava Meal

The fresh cassava root contains about 35 percent dry matter. Dried cassava meal contains 92 percent dry matter (Table 4). The most convenient and practical way of handling cassava is to dry the chopped fresh roots and grind them into a meal. Drying can be accomplished by drying in the sun, either on cement floors covering it with a plastic cover when it rains, or on wood framed trays with mesh bottoms. The toxic effect of prussic acid in cassava is reduced by sun drying or in a forced air oven or open dryer at a moderate temperature. The meal can be stored in a well-ventilated area for a long time. Cassava meal is an excellent energy source because of its highly digestable carbohydrate content. Since it is deficient in methionine, it is essential that the protein supplement used with cassava meal in the diet should be rich in methionine. Experiments show that cassava meal can make up 40 percent of the swine ration and give satisfactory productivity. On the average, cassava yields about 20,000 pounds per acre. On Ponape, the yield is 13,000-15,000 pounds per acre.

3. Copra Meal (Expeller Method)

Copra meal contains moderate amounts of crude protein (20 percent). The primary purpose of including it in swine feed is its relatively high energy content (Table 4) of 1,400 kcal/lb., compared to dried cassava (1,200 kcal/lb.) and dried banana (900 kcal/lb.), and its availability on Ponape makes it advantageous to include it in the feed.

Extensive studies with copra meal show that increasing the level of copra meal in the diet decreases the rate of gain in pigs and increases the feed conversion ratio, probably due to its high fiber content. Good performance can be expected when the proportion of copra meal in the ration is not more than 15-20 percent. The annual copra meal production capacity of the Ponape Coconut Products plant is 130 tons.

4. Fish Meal

Good quality fish meal is an excellent supplement to pig diets composed of bananas and cassava. It contributes the essential amino acids (lysine, methionine, triptophan), major and trace minerals (calcium, phosphorus, sodium, magnesium, potassium, iron, copper, zinc, manganese), and vitamins (vitamin B_{12}, niacin) to the ration (Table 4). A number of experiments show the outstanding feature of fish meal in promoting growth and reducing the feed conversion ratio. This is especially true when added to exclusively vegetable origin diets. The amount of fish meal added to the swine ration depends on the composition of the other ingredients of the diet to balance the essential nutrient deficiencies. But, on the average, it should not be more than 10 percent. Higher levels may adversely affect the quality of the meat by giving it a fishy flavor. This can be avoided if the proportion of fish meal is reduced to about seven percent several weeks before slaughtering.

In compiling the proposed ration, an exception to the usual recommended feeding practices was made by using 15 percent of fish meal instead of the maximum 10 percent. The possible loss in the quality of the meat was traded off for the requirements of essential amino acids, minerals and vitamins contained in the higher proportion of fish meal. Bone and blood meal, as byproducts of a local slaughterhouse, would proportionately reduce the required fish meal import.

The proposed ration generally satisfies the requirement of growing 'finishing' pigs (Table 5). The lower digestible energy content of the ration can be compensated for by feeding higher daily amounts to the pigs. The average required energy of 6,000 kcals per pig per day is usually satisfied by about four pounds of good quality commercial feed per day. In the proposed ration, the equivalent daily amount of feed should be about five pounds.

The apparent deficiencies, resulting from comparing the composition of the ration with the maximum requirements shown, involves only young pigs up to ten weeks old. For these, special commercial "starter" feed may be used. The Vitamin A deficiency in the ration may be overcome by additional provision of green forage to the pigs. The Vitamin D need may be biologically provided by the animals themselves, if exposed to sunshine in a fenced open space. The required amount of salt should be added to the ration.

ECONOMIC FEASIBILITY

The feasibility of swine feed production from locally produced raw materials on an intermediate industrial scale depends on economic considerations. At present time, the amount of imported pig feed is about 400 tons per year. In the following analysis, a feed mill of the same capacity is considered, producing 1 3/4 tons of feed per day. Determination of economic feasibility will depend on:

(A) Amount of Raw Materials Required

(B) Capability of Producing the Required Amount of Raw Materials, and Anticipated Income to Farmers

(C) Estimated Cost of Raw Materials

(D) Operating and Processing Cost

A. Amount of Raw Materials Required

Taking into account the water content of bananas and cassava and the distribution of raw materials in the ration, the following fresh and dried amounts are needed to produce 400 tons (800,000 pounds) of feed:

Table 6: Amount of Raw Materials Required to Produce 400 tons of Feed

	Dried Amount (lbs)	Dry/Fresh Ratio	Fresh Amount (lbs)f
Banana	320,000	1 : 3.1	992,000

Cassava	240,000	1 : 2.3	552,000
Copra Meal	120,000	1 : 1	120,000
Fish meal	120,000	1 : 1	120,000
TOTAL	800,000		1,784,000

If fish meal is substituted with local dried "junk fish,"[8] the amount of fresh fish needed is 348,000 pounds (dry/fresh ratio 1:2.9).

B. Capability of Producing the Required Amount of Raw Materials and Anticipated Income to Farmers

The land needed to produce the required amount of bananas and cassava, assuming open field planting, is as follows:

Table 7: Land Needed to Produce the Required Volumes of Bananas and Cassava

	At the present minimum yield level	At average yield level
Bananas	76 acres	33 acres
Cassava	42 acres	28 acres
TOTAL	118 acres	61 acres

If bananas are planted under coconut trees, the required acreaghe will be higher. Erosion is always a problem on Ponape due to heavy precipitation, but for the estimated 60-120 acres of total production area, scattered across the island, sufficient suitable land is available.

The copra meal requirement would be 46 percent of the present production capacity of the Ponape Coconut Products plant. Fishmeal will have to be imported. However, if junk fish is used to produce fish meal, the daily amount of catch should be 3/4 tons of fish.

Taking into account the materials required, the land needed to produce it, and the required copra meal producing capacity, it appears that the considered 400-ton production of pig feed is attainable on Ponape. The anticipated gross income to banana and cassava farmers, using minimum yields and prices, would be about $77,000 or $650 per acre.

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[8] "Junk fish" is the local name for a diversity of small lagoon fish, as opposed to tuna, bonito, or other large size fish.

C. Estimated Costs of Raw Materials

The problem of establishing a pig feed mill on Ponape is raw material cost. Although bananas and cassava grow very well, they are produced only in limited quantities for family use and for the local markets. The production is haphazard and the practices used in production are primitive and unsystematic. Hence, the demand keeps the price high ($0.05/lb. to as high as $0.15/lb.) for both bananas and cassava. The copra meal output of the Ponape Coconut Products plant is only about 30 percent of its capacity and, since the meal subsidizes other process costs due to undercapacity production, the price is high ($0.10/lb.). The price of imported fish meal is about $0.30/lb. The price of locally available junk fish is very high ($0.30-0.35/lb.). Fresh fish contains about 25 percent dry matter, hence on dry basis (90 percent dry matter) it would cost $0.87-$1.02/lb., excluding drying and processing costs. Using minimum prices, the total cost attributable to the ration would be $125,200 or $0.16/lb. (Table 8).

D. Estimated Processing and Operating Costs

When the costs of raw materials ($0.16/lb.) are combined with operating and maintenance costs ($0.07/lb) such as labor, fuel for processing and packaging (Table 8), producing 400 tons of swine feed using local materials and imported fish meal is prohibitively expensive in financial terms.

CONCLUSIONS

From the results of the study, the following conclusions are apparent:

1. Pigs are an important part of the Ponapean culture and tradition and will continue prominently in the local economic development programs.

2. The presently imported 400 tons per year commercial pig feed can be replaced up to 85 percent by locally produced bananas, cassava and copra meal. An additional 15 percent of imported fish meal will result in an acceptable ration for pigs. The amount of raw materials may be produced without difficulty on the available land and by the capacity of the coconut processing plant. The increase in production will obviously result in greater income to farmers.

3. At present it is not feasible economically to produce local feed without government assistance, since the cost of production exceeds the price of imported feed. Compared to the $0.21/lb. imported pig feed price, the proposed locally produced feed will cost $0.23/lb. on a break-even basis ($0.16/lb. for raw materials and $0.07/lb. for processing). A reasonable profit margin of 10 percent will raise the price to $0.25/lb. The resulting

$0.04/lb. higher price, although presently prohibitive, may become acceptable if, after initial government assistance, the long-term benefits of higher income to farmers, new job opportunities and reduced trade deficit become apparent.

The answer to the prohibitive raw material cost is not easy. The farmers have to be educated and convinced that by improving their production practices and having an assured large volume market for their products at a feed mill, they could earn more money, even on reduced sales prices, than they are earning today. Of course, the benefits of having a local feed mill would ultimately benefit the raw material-producing farmers. The adoption of the outlined production plan by the farmers is likely only if the benefits of the resulting higher income and easily available pig feed is persuasively presented. Perhaps a feed-producing cooperative could solve the problem, but without substantial government help the outlook is gloomy.

The availability of locally produced feed would probably not offset the estimated price increase of $0.04/lb.; however, if the local production were protected by tariffs, the higher price might become acceptable.

Among the many problems to be solved, the following may be considered:

(1) Funding the feed processing plant;

(2) Duty on imported pig feed to match the locally produced feed cost;

(3) Price subsidy to farmers for raw materials;

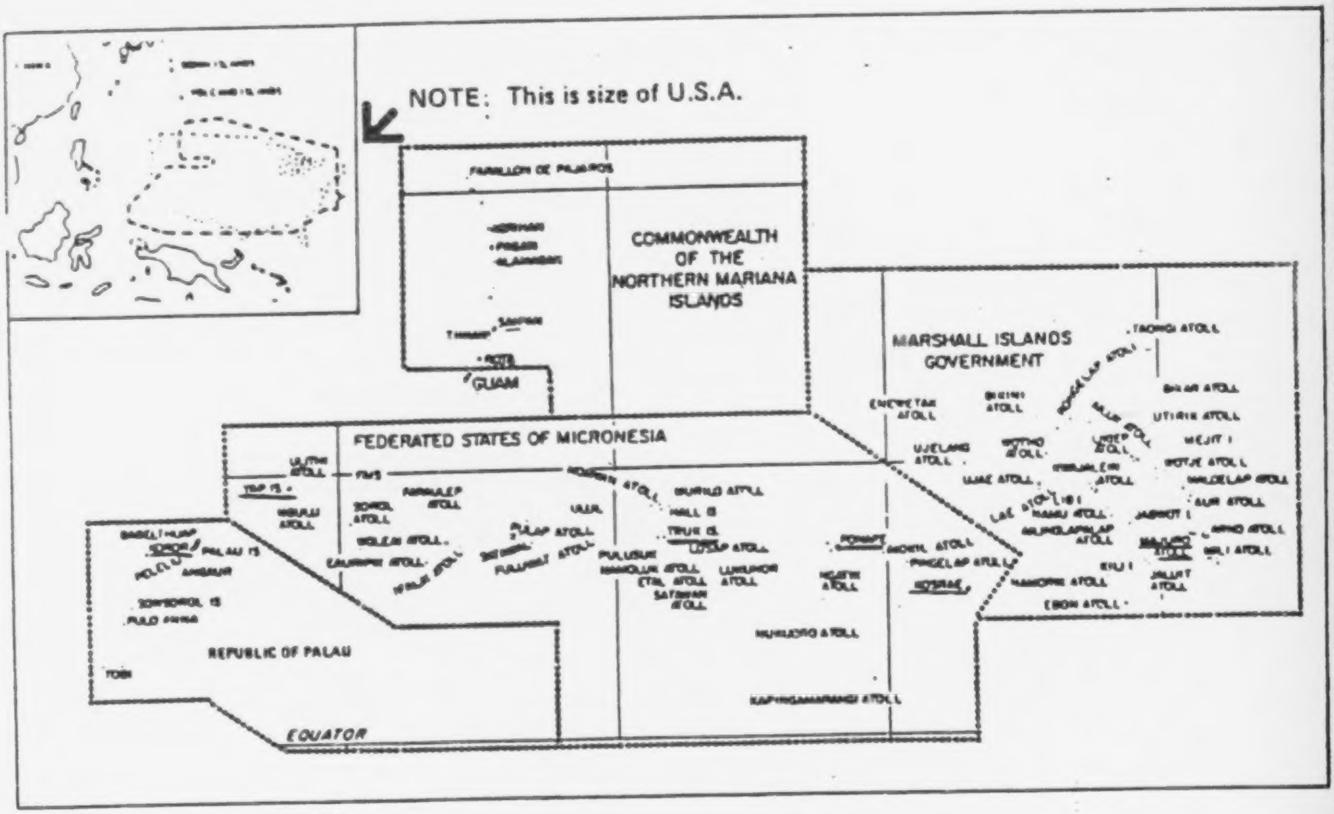
(4) Organization of farmers for raw material production;

(5) Promotion of coconut oil products to increase the copra meal output of the Ponape Coconut Products plant; and

(6) Plan to set up a fish processing plant.

FIGURE 1

M I C R O N E S I A


NOTE: This is size of U.S.A.
COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS
GUAM
MARSHALL ISLANDS GOVERNMENT
FEDERATED STATES OF MICRONESIA
REPUBLIC OF PALAU
EQUATOR
SAIPAN
ROTA
YAP IS.
ULITHI ATOLL
TRUK IS.
PONAPE
KOSRAE
ENEWETAK ATOLL
BIKINI ATOLL
UJELANG ATOLL
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LUKUNOR ATOLL
SATAWAN ATOLL
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MOKIL ATOLL
LIKIEP ATOLL
WOTHO ATOLL
UJAE ATOLL
LAE ATOLL
ALINGLAPLAP ATOLL
NAMORIK ATOLL
TAONGI ATOLL
BIKAR ATOLL
MALOELAP ATOLL
AUR ATOLL
JABWOT I.
KILI I.

TABLE 1: MISCELLANEOUS MICRONESIAN DATA

	AREA Square Miles	POPULATION (1984 U.N. Estimate)	POPULATION per Square Miles
FSM	270	88,000	326
Palau	191	13,000	68
Marshall Islands	68	35,000	515
TOTAL	529	136,000	257
Total Including Ocean Area	2.5 Million		
U.S.A. Land Area	3.6 Million	240,000,000	67

ANNUAL REPRESENTATIVE

	PRECIPITATION Inches	TEMPERATURE (mean average) Degree Fahrenheit
FSM - Ponape	186	80
- Truk	129	81
- Yap	119	80
- Kosrae	187	NA
Palau	156	81
Marshalls - Jaluit	160	81
- Ujelang	80	81

TABLE 2: SWINE PRODUCTION IN MICRONESIA

State Agriculture Survey 1983/1984:	Number of Pigs
Ponape	12,121
Truk	4,158
Yap	960
Kosrae	3,826
Total FSM	21,065
FAO 1982 Yearbook:	
Palau	1,156
Marshall Islands	5,000
Total Micronesia	27,221

TABLE 3: ESTIMATED PRODUCTION COST FOR 4 LB. BROILER CHICKENS

Cost of one day old chick	$0.17
Feed cost	0.50
Other costs, including labor	0.10
Live weight cost	$0.77
Cost of loss of weight a/c processing	0.19
Cost after processing at PATS (no labor cost)	$0.96
Estimated processing cost, including labor	0.20
Total cost after processing	$1.16
Assumed 20% profit to producer	0.23
Producer's sales price	$1.39

TABLE 4: Nutritional Value of the Feed Sources

	Banana dried	Cassava root dried	Copra meal expeller method	Fish meal commercial
Dry matter, %	88	92	90	90
Digestable energy, kcal/lb	900	1200	1400	1400
Crude protein, %	4	3	20	65
Lysine, %	0.05	0.09	0.50	5.00
Methionine, %	-	0.03	0.30	1.70
Cystine, %	-	0.03	0.20	1.00
Triptophan, %	-	0.02	0.20	0.80
Calcium, %	-	0.20	0.20	5.00
Phosphorus, %	-	0.10	0.60	3.00
Niacin, mg/lb.	8	7	11	32
Vitamin B_{12}, mcg/lb.	-	-	-	100

TABLE 5: NUTRITIONAL ANALYSIS OF THE RATION, COMPARED TO THE REQUIREMENTS OF SWINE

	Ration	Requirement
Dry matter, %	90	88-92
Digestable energy, kcal/lb.	1140	1500-1600
Crude protein, %	15	14-20
Lysine, %	0.87	0.50-0.95
Methionine, %	0.31	0.20-0.35
Cystine, %	0.19	0.15-0.35
Triptophan, %	0.16	0.10-0.18
Calcium, %	0.84	0.50-0.80
Phosphorus, %	0.57	0.40-0.60
Sodium Chloride (Salt), %	-	0.40-0.50
Vitamin A, Iu/lb.	-	750-2000
Vitamin D, Iu/lb.	-	75-200
Niacine, mg/lb.	12	5-15
Vitamin B_{12}, mcg/lb.	15	5-10

SOURCE:

Composition of Feeds: University of Hawaii, Department of Animal Science, 1969;

Nutritional Requirements of Swine: National Research Council, Committee on Animal Nutrition, 1968; and other available resources.

TABLE 8: Estimated Production Cost

Total cost attributable to the ration (800,000 lbs) is as follows:

A) Raw Material Costs

Banana (Fresh Basis)	@ $ 0.05	$ 49,600
Cassava (Fresh Basis)	@ $ 0.05	$ 27,600
Copra Meal (Dry Basis)	@ $ 0.10	$ 12,000
Fish Meal (Dry Basis)	@ $ 0.30	$ 36,000
TOTAL RAW MATERIAL COST:		$125,200 ($0.16/lb)

B) Manpower Requirements and Cost

1. Chopping bananas and cassava roots 1 person @ $ 0.80/hour	$ 1,472
2. Drying banana and cassava roots 3 dryers of 1 ton capacity 4 persons @ $ 0.80/hour	5,888
3. Mixing all ingredients 1 1000 lbs. capacity mixer 2 persons @ $ 0.80/hour	2,944
4. Packing the final product in 50 lb bags 2 persons @ $ 0.80/hour	2,944
5. Miscellaneous jobs 1 person @ $ 0.80/hour	1,472
6. Management 1 supervisor @ $1.00/hour	1,840
TOTAL MANPOWER COST:	$ 16,560 ($0.02/lb)

TABLE 8 (continued)

C) Fuel Requirements and Cost

1. Fuel for chopping bananas and cassava 2 gallons/ton @ $1.50	$ 2,316
2. Fuel for drying bananas and cassava 15 gallons/ton @ $1.50	17,370
3. Fuel for mixing all ingredients 10 gallons/ton @ $1.50	6,000
TOTAL FUEL COST:	$ 25,686 ($0.03/lb)

D) Other Expenses[1]

1. Maintenance and insurance 4% of raw material cost	$ 5,008
2. Packaging 16,000 bags @ $ 0.40	6,400
3. Processing losses 5% of raw material cost	6,260
TOTAL OTHER EXPENSES:	$ 17,668 ($0.02/lb)

TOTAL BREAK-EVEN COST:	$185,114 ($0.23/lb)

The operation costs (B - D) of the above model plant are based on estimates comparable to the processes and costs of the Ponape Coconut Products plant, which produces coconut oil from copra.

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[1] Depreciation costs of buildings and equipment not included.

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Background Paper No. 6

FOOD AND FEED PROCESSING TECHNOLOGIES IN THE U.S.-AFFILIATED PACIFIC ISLANDS

by

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ABSTRACT

Food deficits plague the U.S. affiliated Pacific Islands necessitating imports they can ill afford. The size and physical character of the islands limit agricultural production, while the lack of preservation techniques leads to post harvest food losses. There are only a few small to moderate sized food processing facilities on the islands: two tuna packing factories on American Samoa; a pepper processing facility on Ponape; a copra mill on Yap and Majuro; and several family-sized operations for limited processing and packing of citrus, banana, fish, breadfruit, and other foods. Poor marketing methods and pricing structures are endemic to the area.

This report describes the potential for introducing several food processing technologies including refrigeration, dehydration, retort canning, fermentation, irradiation, and minor processing systems. Packaging, food safety and sanitation are major considerations in each case.

The major developmental requirements are adequate production scale, skill level of personnel, and market infrastructure. To meet these the following recommendations are made: 1) establish marketing centers such as local food cooperatives, 2) provide an inter-island quality control program and information system, 3) support local entrepreneurs in food production and processing operations with a credit subsidy program, 4) support the introduction of new crops at island agricultural experiment stations, and 5) support utilization and marketing research and development throughout the island area.

Part I: FOOD TECHNOLOGY DISCIPLINES IN THE PACIFIC

Introduction

The islands of the Pacific Ocean continue to expand their contacts with other islands and nations throughout the world. Growth of food and feed processing technologies tends to augment inter-dependence and reduce vulnerability to food and nutritional deficiences. These technologies essentially transform raw materials into higher valued products with uniform marketing characteristics and longer shelf lives than the source materials. Such technologies tend to encourage specialization and are subject to economies of scale. They also promote the transformation from a barter economy to a cash economy. Immediate as well as slow evolutionary changes may result.

Agricultural production and processing technologies are well known. However, they demand definite skills and standards of practice. The open nature of the business encourages local people to become entrepreneurs. Competition on a world-wide basis, on the other hand, demands efficiencies and standards that discourage entry into food and feed business enterprise.

Besides raw materials, resources critical to processing include energy, water, skilled people, information and supporting infrastructure. The physical nature of the Pacific Islands frequently limits several of these critical resources. These limits are discussed here and must be understood as any technical proposal is considered. The advantages and basic requirements of food and feed processing technologies in the U.S. affiliated Pacific Islands are also presented.

Economic Considerations

The differing economics of tribal groups are related to early colonial control. Those under Spanish rule (the Chamorros, which are mostly in the Saipan area) are more advanced than the Kanakas where private land ownership was not common. Traditionally in these tropical islands, the primary economic activity has been the acquisition of food. In the Marshall Islands, the coral soil base is suitable for coconut trees, breadfruit, taro tako trees, but not very suitable for cultivated agriculture. After the islanders learned copra processing from German merchants coconuts became an important trade commodity. Yam is a more popular food item on Ponape where it is cultivated with minimal effort. Breadfruit is more popular on Truk and taro is the staple on Palau. Taro, yam and sweet potato are the most common foods on Yap.

The natives of Palau and Yap have attained a higher stage of agricultural productivity than the people of the Central Eastern Caroline and Marshall Islands, due primarily to land ownership patterns.

There was no commercial food processing or feed formulation in the Micronesian Islands during the early colonial periods. Food commodities have been bartered since early times, but even minimal processing for preservation has been absent throughout the islands (Yanaihara, 1976).

From a food production and processing standpoint, the Micronesia Island groups with their limited population and industry do not offer a significant market potential. Foreign investers seeking joint ventures with island entrepreneurs have focused on fishing, tourism and constructon although investors have indicated that the lack of infrastructure support industry holds back foreign investment (Nufer, 1978). With continued significant interest in joint ventures, investors might focus on providing tourist services and upgrading the value of local products for export.

The influence of both the United States and Japan on Micronesia is large and these islands depend upon the major countries for their very survival. The interaction between island communities and major countries is expanding but with certain noteworthy fears and constraints. The huge population and financial resources of Japan and the United States are intimidating to communities with relatively few people and an inadequate economic base. Trade imbalances pose debt problems. Tension frequently arises when either Japan or the United States acts without involving the island government. The islands often perceive that their interests are not being protected. For example, a superport in Palau is proposed to serve the interests of Japan. If it is completed, Palau would be economically controlled by Japan's commercial and defense interests (Fluker, et. al., 1981).

Food Deficits

Serious food deficits exist on many of the Pacific Islands. Continually increasing populations affect food availability and employment opportunities. The islands' low agricultural productivity has kept farming at subsistence levels insufficient to serve family needs and certainly insufficient to yield a surplus for sale to urban centers. Where agricultural productivity is low, health care, education standards and the quality of life are usually also poor (Wortman, 1976).

Sherman (1976) explained that rural overpopulation relative to a given land mass is not a simple concept. Rather the number of people a given quantity of land can support depends on the technical skill levels, transport and communications, capital and other constraints. Increased density does not necessarily imply lower output per individual; output is based upon degree of industralization and productivity. The rate of industrial development, moreover, is largely conditioned by progress in the agricultural sector.

The potential for increasing both agricultural production and productivity is high for many of the Pacific Islands. Agricultural yields increase rapidly with improved management methods, increased fertilizer applications, timely pest control and improved preservation techniques that prevent losses in the field and marketplace. Resistance to change impedes progress but can be overcome if basic values of society are not violated. Agriculture is changing its technology rapidly and now requires a labor force as skilled and trained as manufacturing industries. Governments must take effective action to assist development. Needed are 1) vocational programs in agriculture, health, nutrition and industrial arts; 2) a network of financial services to aid farmers and business people; 3) communication systems that provide timely information and responses to information needs; and 4) improvement of the island infrastructure to enable free movement of people and products.

People produce and process agricultural commodities only when it is profitable to do so. Fair prices must be paid to encourage the surplus production necessary for processing. Removal of the surplus through preservation and marketing is necessary to sustain fair prices and encourage future production. Vulnerability to losses in the field, market and during storage must be reduced or eliminated. Control of critical resources and points of vulnerability requires complex managerial and governmental cooperation. Conflict can often arise over economic and environmental issues and over political control. Conflict resolution, thus, must also be a part of the development program.

Food Processing in the U.S. Affiliated Pacific Islands

Several small food processing facilities are scattered throughout the U.S. affiliated Pacific Islands. Pepper production and processing takes place on Ponape, fish processing on American Samoa, and coconut processing on Majuro and Yap. Local bakeries exist throughout the more populated islands. The more populated islands have small food storage centers for distribution of imported foods. Moen Island in the Truk group has a large food storage center for P.L. 480 food donations from the United States.

Many families do preliminary food preparation and limited processing for their own needs. These include the drying of fish, breadfruit and coconuts; fermentations of some fruits; salting of fish and very limited freezing. The expansion or intensification of these activities depends on increased supplies and a cash incentive.

Dehydration, along with smoking and salting are among the least complex applications for processing foods and feeds. Dehydration is certainly the primary application in the preservation of feeds for livestock. The desire for improved flavor and texture limit local marketing of many dehydrated foods for human consumption, particularly when fresh foods are readily available. However, dehydration products remain quite viable for off-island marketing. To cover this activity it is necessary to intensify the cultivation of crops and expand animal raising, and commercial fishing.

Food dehydration has been practiced throughout the Pacific Islands region since earliest times for cononut, breadfruit, fish, berries and some selected vegetables. Natural sun drying is frequently used for grains, seeds, tubers and some fruits and is economical when there is substantial sunny periods during the day and low or moderate relative humidity. Sun drying makes products susceptible to contamination by dirt and insects however, and, frequently will not bring moisture levels low enough for long term preservation.

Artifical drying is viable for expanding the sales opportunities of many island products. Dehydration can be accomplished with ovens using local energy sources. It is now practiced with pepper production on Ponape and with copra and fish production on several islands. Artificial dryers remove moisture from foods with forced heated air. Several drying hours are usually required to reduce the moisture context to under 12 percent.

A large number of chemical and physical changes take place during the drying process; some foods become unsatisfactory for modern markets. Drying combined with other preservation methods (smoking, salting), and additives that protect flavor, color or other characteristics, enhance some foods. Ascorbic acid, sulfites, and sugar help prevent color changes. Salt at levels above 18 percent prevent microbial growth and spoilage. Freeze drying enhances the flavor of some products and helps protect the cellular integrity of the food but it is much more technical and energy intensive than normal drying. It has limited applications in the Pacific Island region and is only recommended for certain specialized products such as baby food or gourmet foods.

Spices, seasonings and tropical fruit flavors appear to be the most viable areas for expansion of dehydrated products. By-products and waste products of dried foods can be considered for animal feed formulations.

Retort canning (pressure cooking) has been proposed by many church groups and cooperative organizations as a means for preserving fruits and vegetables. Acid type fruit products are easily canned without substantial health hazards. The acid level prevents spoilage by most toxic organisms.

Retort canning of non-acid foods such as vegetables and meats presents a potential health hazard if certain quality control procedures are not followed. Retort canning of non-acid foods is not recommended as a food process without control and monitoring by well trained people. Retort canning equipment is readily available and easy to use. The Ball Corporation of Muncie, Indiana has developed equipment, appropriate for a community cannery that costs under $4,000 (Jackson and Mehrer, 1978). Food Preservation Systems of New Windsor, Maryland also provides food canning technology for less developed areas of the world.

Refrigeration of foods for short-term storage, and freezing for long-term storage is safe, maintains flavor and is ideal for a wide variety of foods. Refrigeration of foods under controlled atmosphere conditions (preservation with carbon-dioxide gas) provides excellent storage for certain fruits and vegetables up to 21 days. Refrigeration and food freezing facilities other than household refrigerators is largely limited to the main hotels and restaurants throughout the Micronesian Islands. In American Samoa the fish processing factory has a large commerical refrigeration and freezing facility. Both short-term refrigeration and long-term freezing facilities are needed on all islands with substantial populations. The substantial energy needed for freezing must be available before implementing a freezing facility. Easy processing and packaging and acceptance of products world-wide make the potential for frozen tropical food excellent. The expansion of basic frozen fruits for such market applications as flavor blends and children's frozen snack foods should be considered.

Feed milling and associated grinding and mixing of foods and feeds are essentially non-existent in Pacific Islands other than Hawaii. The use of hammer mills and roller mills for grinding grain and other grinding operations are technically feasible for most island communities including those with very small land mass. Mills are not expensive or complex relative to the volume of product handled. They facilitate production of animal feeds and some food formulations. Grinding and milling facilities are recommended for inclusion in equipment outlays for all agricultural experiment stations and all feed and food centers established.

Small food presses and oil extraction equipment are available on several islands. Coconut oil is an important product on a few islands. Copra is transported from these islands to nearby processing plants where the oil is physically and chemically extracted. This is a viable industry and should be expanded. Ivory nut palm grows well on several islands but has yet to be used commercially. Expansion of the oil palm industry should also be encouraged: it is adaptable to the climate of most islands and can provide a base industry for local consumption and export. Also recommended is the introduction of oil seed crops such as winged bean as a base for both foods and feeds. A high protein cake remains after oil extraction from many of these products.

Secondary Food Processing Systems

Other than pepper processing on Ponape, there are no commercial systems of fermentation, distillation, brining, pickling, gassing, or sugaring in the island groups. These secondary food processing methods all have potential for certain products aimed at specific local markets. (The volume requirements of world markets are too high for the islands). Fermentation and distillation of carbohydrate containing foods are simple technologies that require minimal equipment and are amenable to small scale production. Quality control and governmental policy may be necessary as alcohol spirits produced from foods can become social problems through addiction. Taro and cassava are primary carbohydrate crops that can be fermented into low grade alcohol sources. Tropical fruits can be fermented and distilled into very high value products. In both cases large quantities are needed before export markets can be considered.

The Ponape pepper industry has proven to be a valuable integrated production/processing/marketing project. It illustrates how a high value crop increases in value through processing. The processing includes slight fermentation to season the seeds, roasting, drying and packaging. Production has been limited by availability of the crop from small farms. It could be readily expanded to include many other islands.

Food Irradiation

Preservation of foods by irradiation has been employed both experimentally and commercially in many countries for several decades. It was used in France in the 1930's and by the U.S. military experimentally in the 1950's. Low doses of approximately 100,000 rads are used to prevent sprouting of potatoes and other tubers, insect destruction, and molding of fruits and vegetables. Medium and high doses of irradiation can sterilize foods for long term storage. Irradiation is a viable preservation tool in areas where refrigeration and retort processing are not readily available. The U.S. Food and Drug Administration (FDA) has approved the use of low doses of ionizing radiation to reduce microbial contamination in some spices and seasonings. Approval of somewhat higher doses (up to 3,000,000 rads) for insect control and fruit and vegetable preservation is expected later this year.

Ionizing irradiation at controlled levels can extend the shelf life of many fruits, vegetables, fish and poultry without adverse flavor changes or toxic effects. High sterilization levels can cause chemical changes within foods, and do affect flavor. People from several areas of the Pacific Island groups are sensitive to atomic food treatments as a result of the hydrogen bomb testing that took place in the Pacific region. The United States has been more conservative in approving irradiation treated foods than many other countries, as irradiation is associated with cancer in many peoples' minds. Thirty countries have approved irradiation as a commercial treatment to extend the shelf life of such products as strawberries, mangoes, shrimp, papayas, bananas, and many other tropical products. The Codex Alimentarius Commission, which develops world standards for foods, classifies irradiation as a process and not as an additive, and recommends that irradiated foods be labeled "treated by ionizing energy" (Swientek, 1985). The costs of irradiation varies considerably at low volumes, but can be competitive with other processing methods at moderate to high volumes.

Irradiation is primarily by gamma rays (cobalt-60 or cesium-137 as a source), x-rays, or high-velocity electrons. Each method has specific use attributes. Within the Pacific Islands irradiation would be a viable technology for extending the shelf life of tropical fruits, fish, shrimp, and for insect control of spices. An irradiation facility could also sterilize medical surgical instruments for local hospitals and physicians.

Food Packaging

Packaging is critical to the sanitation and market value of foods. The type of packaging selected often relates to the method of processing. Retort canning usually involves metal cans or glass bottles. Frozen and dehydrated foods are more often packaged in flexible plastics; beverages in glass containers, light weight aluminum cans or disposable plastic coated paperboard cartons. The islands in the Pacific must import nearly all packaging materials for marketable products. Local packaging materials are limited to natural leaves and fibers which are useful for village trade but of little value for extended markets. Disposal is also a problem and reuseable (ideally glass) containers should be given high priority. However, reuseable containers are not appropriate for export or inter-island exchange. Bulk packaging or plastic containers are more practical for export trade.

Sanitation

Food losses and human health problems both decrease as sanitation standards improve. Rats and parasites are a problem on nearly all of the islands. Their numbers increase when garbage, trash and food processing wastes are not disposed of properly. A viable food and feed processing industry must keep rodents, parasites and other common pests to a minimum; insure that all employees practice good personal hygiene; and store food in a protected depository. Bacterial contamination is minimized only through rigid quality control programs and constant product monitoring.

Food Development Priorities for Pacific Islands

1. Food Safety:

Any change from the traditional methods of producing and handling food items could potentially lead to spoilage, toxicity or other unhealthful consequences, particularly when higher levels of technology are introduced without adequate training of personnel or quality control. Thus food safety and quality control programs must be introduced with any new food operations.

2. Food losses:

It makes no sense to produce food that spoils before harvest or in post-harvest handling. Losses due to insects, rodents and lack of refrigeration exceed 30 percent of production in many less developed areas. It is easier to prevent such loss than to expand and intensify production and processing.

3. Price protection and market structure:

Monopolies in food production may develop within a limited island territory due to insufficient competition and market choice. Thus a pricing policy and market structure must be created before a product is developed.

4. Environmental characteristics:

Each Pacific island has its own unique environmental characteristics. These affect choices of agronomic methodology and the marketing attributes of tropical foods and feeds. Hence, the physical and biological characteristics of each product, packaging material and storage vessel should be well understood, and must be compatible with local environmental conditions.

5. Transfer of technology:

Selection of appropriate equipment, methods, products and training should accompany each suggested change prior to implementation.

6. Underutilized resources:

Many energy sources, food products, and potential feed products are not fully utilized on the islands. These should be identified and a means for their utilization established.

7. Introduction of new food and feed crops and animals:

New foods and feeds must be introduced to the area on an experimental or trial basis, and expanded wherever feasible. Adaptation to the local social, cultural and climatic environments is essential.

8. Energy resource development:

Energy requirements frequently limit development of a food and/or feed processing facility. Adequate energy may be unavailable or cost prohibitive. Alternate energy sources must then be considered, including conversion of waste products, sunlight, wind, and water power.

9. Food processing/storage facilitaties:

Food preservation technologies must be available to all populated islands lacking sufficient preservation methods. In many cases this means bulk refrigeration or freezing facilities. Storage warehouse and/or silos for dried foods and feeds should also be considered.

10. Export marketing:

When foods or feeds are produced in surplus of local needs, shipping to other islands or to foreign countries must be encouraged to build a trade program and provide cash for outside purchases.

Cooperatives

The implementation of agricultural cooperatives is a viable option for all of the Pacific Islands. Cooperatives tend to increase agricultural production and distribute the benefits equitably to the village and rural population. Village support and individual member participation are important to the success of a cooperative. The communal nature of island land holdings and the equity requirements of processing facilities are compatible with the formation of an agricultural cooperative. Cooperatives can become a source of credit and materials to farm producers and a means to attracting government credit and resource.

The introduction of food processing and commercial agriculture to an island community will transform the society. Areas with low productivity and low income depend almost entirely upon local products and knowledge. However as income and productivity increase, reliance on local inputs shifts to outside products and knowledge. Divisions of labor become more specialized during agricultural development. Commercial agriculture complements non-agricultural industrialization. Island communities become integrated with other islands and countries through their market information needs.

Part II Food and Feed Processing by Island Communities

Yap (See note 1)

Like many Micronesian islands, Yap no longer supports itself in local food production. The need for self- sufficiency, especially in food and feed production, has been stressed to State Senator Tony Ganngiyan and Deputy Director of Resources and Development Constantine Yinug. Food imports place a great financial burden on an island economy. Considerable acreage is set aside for taro fields which are seldom cared for, let alone fully utilized for food. Yap's climate is ideal for the growth of many tropical fruits yet many small groves are unattended. Fish abound in the surrounding waters, yet before the opening of the cooperative fish store fish were caught on a subsistence basis only. To this day more canned mackerel is consumed than local fresh fish.

Yap is seriously trying to make better use of the food and feed production capabilities of its bountiful but fragile environment. Under the auspices of a food cooperative the State has procured a small fleet of fishing vessels to exploit the rich fishing waters beyond the reach of local subsistence fishermen. An ice plant has just been completed to facilitate the safe and organoleptically sound handling of the fleet's daily catch. It will serve the fishermen's needs and the requirements of the cooperative's wharfside fish and produce stands.

Near the cooperative store is a copra mill. Its steam generator is equipped to burn locally produced biomass for the energy and heat needed to process all the copra now harvested on the island.

Dr. Thavalingam Mailuaganampillai, a United Nations Volunteer, and swine production expert working with the Division of Agriculture and Forestry of Yap's Department of Resources and Development is finishing work on swine rations made from copra, fish by-products, and other underutilized raw materials. Initial testing of his formulations indicate a potential for considerable savings over the purchase of imported premixed swine feed. A pilot feed mill is needed to produce enough of this formulation to supply local hog producers for a fair evaluation of the concept.

Truk (See note 1)

There are no commercial food processing or feed production facilities on Truk. Chief of Agriculture Arthur Ansin is trying to prove the feasibility of a broiler chicken operation using local cassava, breadfruit, copra, and fish by-products as feed. Presently disease and the lack of feed availability are major problems. Truk needs a pilot feed mill to test the feasibility of the broiler production concept.

A serious problem of Truk is the scarcity of potable water. All water is from cistern collection of rainfall. Water flow is sporadic and dependable for only or two hours a day.

Ponape (See note 1)

Ponape has problems similar to other Pacific Island communities. Local food industry is limited to a pepper processing factory and a few small pork production facilities. Pork is one of the islander's favorite foods, but the development of a pork production industry here is prevented by the lack of an affordable, balanced swine ration. One 50 kilogram bag of the most popular imported swine feed costs over $18.00 at the local consumer cooperative. This makes local pork too expensive for daily consumption in a society with Ponape's average annual income.

Dr. Miklos Szentkiralyi of the Ponape Agricultural and Trade School presently seeks funding to test a balanced ration milled from local raw materials such as cassava, copra, shark meat, seaweed, and legumes. If these local materials can be procured and processed at reasonable cost, pork could be produced commercially. The Peace Corps has put considerable effort over the past four years into an aquaculture project for drying and processing marine algae into food grade gum for export. However, many problems must be overcome before carrageenan production becomes a reality.

Guam

The duty free port of Guam has a strong infrastructure to support business. The local economy is dominated by the U.S. military facilities and local government employment opportunities. The island has over 65 restaurants, but no organized food or feed processing facilities. Guam encourages foreign investment and has strong potential for growth in trade and commerce with the Far East and the United States. The current economy exceeds $1.2 billion per year.

Sales of locally produced agricultural commodities was $6.3 million in 1982. Still most food consumed was imported. A local group of government personnel and people with food interests met to discuss areas of major concern. These were stated as "centralized communications and information, grading and quality control, and scheduled planting land forecasting" (Anonymous, 1983 Guam Annual Economic Review). The local government recently assumed responsibility for the Ija Agricultural Research project which seeks to establish an "Institutional Kitchen" for local people to pickle, can, freeze or otherwise process farm products.

There is also a substantial aquaculture development program on Guam: 40 acres of ponds for prawn culture, 27 acres for penacid shrimp, tilapia, carp and catfish, and a 10 acre eel farm. Marketing and processing facilities have not yet been fully developed to support these projects.

Marshall Islands

During 1984 the Tobolar copra processing plant shipped 500 tons of copra oil to the United States. The Copra Stabilization Board fixed the price at 20 cents per pound. Also during 1984 the Marshall Islands were awarded a $2,000,000 grant to begin construction of the Majuro Fishing Base. This base will produce refueling, freezing, storage, marketing and re-supply facilities to area fishing boats. The cold storage plant is planned to have a capacity of 150 tons (Anonymous, 1984 Trust Territory of the Pacific Islands). A new agreement between the Marshall Islands and Japan gives Japanese fishing boats operating licenses for the local waters.

Northern Mariana Islands

In the Commonwealth of the Northern Mariana Islands, imported animal feeds have become too expensive for farmers to compete with imported finished products. There is an urgent need for locally processed and manufactured animal feeds to replace imported feeds. More than 400 acres of farmland were cleared for cultivation during 1984. Fruit trees (mainly breadfruits) were planted on much of the acreage. Some is cattle pasture. Fishing continues to be a semi-subsistence operation with fewer than 10 boats supporting a commercial fishing business. Several edible varieties of fish, including yellow fin, skipjack, tuna, marlin, mahi-mahi, wahoo, jacks and snappers, are locally abundant, as are lobster and deep-water shrimp. It is estimated that over 8,000 metric tons of fish are harvested each year by Japanese and Korean fishing vessels within 200 miles of the Commonwealth. A commercial slaughterhouse was opened in late 1984 for slaughter and sale of local pork and beef. Also in Saipan, the ASLito Digester Project generates energy from local livestock and aquaculture. In addition to its two disgesters there are two other digesters on Saipan, one on Tinian and one on Rota. These produce biogas for energy and fertilizer products for agriculture (Anonymous, 1984 Trust Territory of the Pacific Islands).

Palau

In the Republic of Palau the Division of Agriculture operates the only feed mill for the production of poultry and hog feed. It generates 12 tons of feed per month, all of which is sold locally (Anonymous, 1984 Trust Territory of the Pacific Islands).

American Samoa (See note 1)

American Samoa has two major fish processing plants that provide substantial local employment and dominate the local economy. These facilities can tuna and mackerel for worldwide export. Complementary businesses to utilize the by-products have not been developed. A local food cooperative market exists, but it does not do food or feed processing.

On American Samoa, the government continues to emphasize the expansion of agriculture--now a subsistence activity. Increases were noted for bananas, taro, and vegetables. Still many of these items were heavily imported to satisfy local demand most months of the year. There are no commercial processing and preservation facilities to encourage surplus local production. Two fish canneries are operated by Star Kist and Van Camp on the island of Tutuila. Cannery by-products have been experimentally used as both animal feed and for methane generation. However, a commercial feed facility is needed to produce local formulated animal feeds. Currently most animal feed is imported from Western Samoa (Mann et. al., 1981)

Several varieties of vegetables are grown on American Samoa including carrots, tomatoes and cabbages. None do well in the local climate and they are subject to rapid spoilage. Winged bean is grown successfully and could be readily expanded if feed and food cash markets existed for surplus production. A small abbatoir for goat and pig processing is under consideration (Mann et. al, 1981).

Part III Recommendations for Action

1. Food marketing centers need to be established or enhanced in each island community. These would include appropriate processing facilities and storage areas and would facilitate fair pricing and trading programs. Food cooperatives could serve this purpose.
2. An inter-island food quality assurance program needs to be established to enhance food safety, fair prices and standardized products for inter-island trade.
3. A food information program needs to be established to report prices, quality and volume of food and feed commodities. The information system could help balance supply and demand, improve nutrition and sanitation, promote new product uses and identify problem areas.
4. Support for private business (financial incentives through credit subsidies or price guarantees) is essential as an incentive to agricultural production and processing.
5. New crops should be introduced at existing agricultural experiment stations. These could include a wide variety of fruits, vegetables (beans), melons, energy crops, and high protein animal products.
6. An appropriate research and development program for utilization and

marketing of feed and food commodities should be established, perhaps on local island agricultural experiment farms. In addition the establishment of processing and marketing infrastructure in the form of food and feed processing centers on elected islands would promote self sufficiency in food production and help promote long term island development. Local agricultural producers and potential producers might expand and intensify their commodity production programs if a cash market were assured. Commercial investors would also be attracted if they had confidence that surplus food and feed commodities would be available on a substained basis.

A food and feed processing center should:

1. Provide a strong communication linkage between the processing facility and farmers. The staff of this facility would identify areas of commercial potential and interest and determine the feasibility of commodity production and processing. It would provide support technology to farm producers and marketers.

2. Facilitate the commercialization of tropical crops and processed foods. This would include the introduction of speciality products such as tropical melons and fruits and provision of supporting technology for product development.

3. Insure product safety with a food quality assurance program.

4. Be sensitive to the potential socio-cultural impact of agricultural intensification and commercialization.

5. Establish an integrated information system that would form a data base for production, marketing, pricing and government policy.

6. Provide organized training and extension education services on an on-going basis.

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Footnote:

1. Dr. Woodrow C. Monte traveled to Yap, Truk, Pohnpei and American Samoa during June and July 1985 and held personal communications with several leaders of each island visited.

Food Preservation Methods and Constraints

Method	Major Uses	Constraints
Dehydration	Small fruits seeds, grains coconut, fish	Packaging, flavor loss mold
Retort canning	Vegetables fruits, beverages	High energy use, quality control
Refrigeration	Short term storage	Availability
Freezing	Long term storage	Availability
Irradiation	Limited	Consumer acceptance
Chemical inhibitors	Fish, meat, fruit	Flavor changes, toxicity, allergens
Antibiotics	Fish	Allergens, sensitivity
Gas	Fruits, vegetables	Availability
Fermentation	Fruits, vegetables beverages	Flavor, toxicity
Smoke	Meat, fish	Flavor, mold
Freeze drying	Vegetables	Cost, availability
Pasteurization	Beverages, fruits	Flavor, toxicity

Background Paper No. 7

AGRICULTURAL PESTS AND PEST MANAGEMENT TECHNOLOGY IN U.S.-AFFILIATED PACIFIC ISLANDS

by

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ABSTRACT

Crop losses in the tropics are due, in large part, to pest damage incurred by insects, weeds and plant diseases. In the U.S.-Affiliated Pacific Islands the incidence of pest infestation is on the rise due to the introduction of pests through increased air and sea traffic.

Various strategies have or are being developed to deal with pest problems. They range from simple traditional methods and intercropping schemes to technologically more demanding methods of biological control, chemical control and Integrated Pest Management. Traditional methods and planting schemes have evolved to successfully cultivate traditional crops such as coconut, bananas, breadfruit and taro. Biological control is environmentally safe, economical to the farmer and works best on the traditional long-term crops. With crop-threatening pest outbreaks, an Integrated Pest Management strategy, with its timely and prudent application of chemical control, is warranted. Pesticide usage, however, demands that special consideration be given to safety, economic factors and environmental impact. Pest eradication is feasible on small islands, but technical requirements are demanding and costly.

Regional research to support pest management technology is being conducted at the University of Guam, the American Samoa Community College and the Ponape Agriculture and Trade School. Efforts have primarily focused on traditional cropping methods, biological control and Integrated Pest Management. The Hawaii Department of Agriculture and Universities of Guam and Hawaii have been instrumental in disseminating biological control agents throughout the region.

A tremendous need exists to coordinate research efforts in the Pacific, given the limited number of personnel and the wide range of problems. The formation of a laison office to coordinate cooperation with regional organizations would greatly expand research opportunities while preventing duplication of efforts. A crucial supportive measure is the development of an information retrieval system and an efficient communications system to link regional personnel.

On a national level supportive funding for agricultural-related research with tropical emphasis may be channeled through the U.S. Department of Agriculture and Section 406 of the Food for Peace Act. Support for the establishment or upgrading of facilities and personnel related to quarantine would greatly assist pest management efforts through its preventative approach of pest exclusion. Environmental Protection Agency requirements for pesticide registration and labeling need evaluation in considering local languages and limited experimental capabilities. Matching-fund prerequisites for Federal grants require reconsideration due to prevalence of limited supportive resources.

Scholarships for students, training workshops for both extension workers and farmers, and expansion of professional capabilities demand support. The unique setting of the U.S.-Affiliated Pacific Islands should also be emphasized in identifying and promoting research opportunities.

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INTRODUCTION

Recent decades have witnessed a steady decline in food production self-sufficiency with a concomitant increase in processed food imports for the U.S.-Affiliated Pacific Islands (Mark, 1982). This dependency upon imports even extends to staple crops. For example, American Samoa imported 145 tons of taro, 13 tons of bananas and 12 tons of cabbage from neighboring Western Samoa during the last quarter of 1984 (American Samoa Department of Agriculture, 1985). However, evidence exists which suggests American Samoans are not yet interested in abandoning their traditional self-sufficiency altogether. Over 80% of all households still grow a portion of their food (U.S. Army Corps of Engineers, 1979). Furthermore, an accelerated agricultural development program may be the best means of ensuring self-sustaining growth for the geographically isolated and economically underdeveloped U.S.-Affiliated Pacific Islands (Mark, 1982).

Because both the need and the interest for local food production exist, factors contributing to its decline must be examined. This report focuses on the constraints which crop pests impose on food production in the U.S.-Affiliated Pacific Islands with special emphasis on American Samoa, and suggests appropriate strategies for dealing with them.

Crop losses due to field pests, which includes insects, weeds and plant diseases, are estimated to be about 35% worldwide. In the tropics these losses are estimated at about 40% (Youdeowei and Service, 1983). Mammal and bird losses appear to be more severe in the tropics and subtropics than in the temperate region, but are still low compared with losses attributed to the aforementioned three major pest groups (Pimentel, 1981).

Post harvest losses, during storage are estimated to range from 10 to 20% worldwide. The major pests of harvested foods are microorganisms, insects and rodents. When postharvest losses and preharvest losses are added together, worldwide food losses due to pests are estimated to be about 45% (Pimentel, 1981).

Effective pest management practices are, therefore, essential for the successful production of food crops. In addition to ecological considerations, cultural mores and economic trends must also be considered in developing these pest management technologies.

Improvement and application of suitable technologies may lead to an expanded agricultural industry resulting in increased employment, increased income and tax revenues, an improved balance of trade, improved living standard and better nutrition (Mark and Plasch, 1982)

II. Status of Agricultural Pests

The major agricultural pests of tropical countries are insects, weeds and plant diseases. In the U.S.-Affiliated Pacific Islands, damage has only been documented for losses due to field pests, not storage pests. This is not to say that pests of stored produce do not exist, only that damage caused by field pests were considered more important and were therefore reported (Appendices 1 and 2).

Crop losses due to weeds are greater than those from either insects or plant diseases and farmers in developing nations spend the greater part of their labor in controlling weeds (Burnside, 1979). Yet, interestingly, of those U.S.-Affiliated Pacific Islands responding to a survey, (See Appendix 2), none listed weeds as major agricultural pests. This may be because economic loss estimates are very difficult to obtain and research efforts are focused toward the control of insect field pests. Results of the above-mentioned pest survey are listed in Table 1. A comprehensive listing of pests is given in Appendix 4. Because of the similarities between the Pacific Island floras, the weed pests listed for American Samoa may also apply to some extent to other islands (Whistler, 1983).

Pest outbreaks are a result of a combination of factors. These include the practice of monoculture planting, where a large area planted in a single crop offers a great potential for pest problems. This threat occurs because there are no other crops interplanted which might act beneficially to either divert or repel pests or attract natural enemies of the pest. Continuous culture or a monoculture of one crop in one location for several years, encourages nutrient depletion of the soil which may increase the crop's susceptibility to plant diseases as well as enhance the build up of pathogenic microorganisms in the soil. Pest outbreaks also occur because of the pest's evolved tolerance to certain synthetic pesticides which had been used for their control. This is particularly true for the tropics, in which the U.S.-Affiliated Pacific Islands are located, where there is no cold winter season to serve as an environmental check on pest populations. Pest species thrive year-round, to reproduce continuously, thereby rapidly adapting to change or stress. By the end of 1980, resistance appeared in over 428 insect and acarine species of which 61% are of agricultural importance (Georghiou and Saito, 1985). Accidental introduction of pests at ports of entry is also an important cause of pest outbreaks.

Since the end of World War II, control measures focused on the use of synthetic pesticides. Initial successes with the insecticide DDT in controlling vectors of typhus and malaria, and with the herbicide 2,4-D in controlling weeds, prompted optimism for the achievement of a pest-free environment. Postwar pesticides had a major impact upon control of agricultural pests. With significant success at a relatively low cost, synthetic organic insecticides and herbicides rapidly became a primary means of pest control in agricultural regions.

However, these early successes were soon overshadowed by four basic problems which arose from the heavy dependence on pesticides: 1. development of resistance to the chemicals by various pests; 2. sudden resurgence of some target pests to even higher levels after the initial drop; 3. induced outbreaks of secondary pests to even higher levels; and 4. environmental contamination (Lewis, 1981). Current pest management research strives to circumvent the hazards of toxic residues and to provide more permanent and ecologically harmonious pest management procedures such as biological control and Integrated Pest Management (Price, 1975).

III. Pest Management Practices

The majority of pests in the Pacific islands were introduced by man. In the past 15 years new pests appeared in Guam at a rate of almost 2 per year owing, in large part, to Guam's high influx of aircraft traffic (Maddison, Personal Communication, 1985).

It is apparent that breaches of quarantine occur throughout the Pacific Basin. This may be due to the low status of agriculture in U.S.-administered territories (ibid.). In those Pacific nations that are more dependent on agriculture, there is an increasing perception of the American-administered and the French-administered territories as being points of entry of various agricultural pests (ibid.). The strengthening of quarantine is viewed as a top priority measure.

To counter new and existing agricultural pests, various strategies are employed. These are categorized and described below:

A. Traditional Pest Management techniques are used by many subsistence farmers and, except for Guam and Saipan, subsistence farming remains the principal form of agriculture on the U.S.-Affiliated Pacific Islands. These are often centuries-old techniques that require little capital. They include slash and burn to clear new plantations of natural vegetation, slashing, hoeing and mulching to control weeds, covering newly sown ground with coconut thatch to thwart birds as well as to mulch and constructing barricades against feral pigs and goats. These methods have a minimum impact on the environment, but are labor intensive. As labor becomes more scarce and expensive, traditional techniques become increasingly more impractical.

Cultural methods such as crop rotation, field sanitation, use of disease- and pest-free planting material, planting resistant crop varieties and shifting cultivation are common (Ansin and Raynor, personal communication, 1985). Practices have evolved to handle specific situations. For example, in Ponape nematode problems on bananas are controlled using the following method: Banana suckers are prepared for planting by first removing the roots plus the outer one-fourth inch of the corm and then drying the corm for 3 days before planting. Preferably, corms are planted into new ground and deposited on a bed of ashes (Raynor, personal communication, 1985).

Traditional cropping systems which have evolved both maximize land productivity and play a role in pest management. These traditional cropping systems can best be described as intercropping, multiple cropping or polyculture cropping. These terms apply to the practice of planting two or more crops together in a given area, either simultaneously or sequentially. It may appear that the farmer has randomly planted crops such as taro, banana, breadfruit, papaya, yams and coconut. However, these planting schemes have developed as a result of centuries of cultural and biological evolution which have best adapted them to local conditions (Egger, 1981 in Altieri, 1984). Using these methods, farmers have been able to meet their subsistence needs without heavy dependence on mechanization required for chemical fertilizers and pesticides (Harwood, 1981).

These cropping schemes have evolved because damage or loss due to pests have been minimal. It is therefore important to examine the factors that have contributed to the reduction of pest infestations and evaluate their potential for managing pests on a larger scale.

The effectiveness of intercropping in reducing pests may be attributed to several types of interference factors that prevent the pest from finding the host plant. First of all, when several types of plants are planted in close proximity, one plant may act as a physical barrier, partially concealing or camouflaging the susceptible crop from pests. Secondly, companion plants may be emitting chemicals, known as semiochemicals, that serve to confuse or repel potential pests, or attract beneficial insects (Jackson and Lewis, 1981). For example, in American

Samoa a traditional practice to prevent plant devastation by a deadly *Phytophthora* rot is planting *Crinum asiaticum* around susceptible plants. This herb reportedly has repellent effects (Misa, 1985). America Samoan vegetable gardeners have also reduced the presence of several destructive caterpillars on their cabbage by interplanting with onions, and crediting the strong odor of the onion with repellency (Personal observation). Similar techniques have been employed by organic gardeners worldwide.

Intercropping, by providing diverse habitats, also encourages the presence of the natural enemies of pests. In American Samoa, there is a traditional practice of growing *Coleus blumei* throughout a plantation soon to be planted with taro. It is believed that flies and wasps that parasitize the ubiquitous destructive taro armyworm frequent the *Coleus* for a nectar meal. Therefore, planting *Coleus* in or around the taro field may indirectly reduce the presence of the armyworm.

Detection and confirmation of similar associations would greatly assist pest management efforts in the U.S.-Affiliated Pacific Islands. Isolation, identification and utilization of semiochemicals would implement an Integrated Pest Management (IPM) program. Research into investigating their potential is being conducted in California and elsewhere (Altieri, personal communication, 1985).

One adaptation of polyculture in the Pacific is agroforestry in Ponope (Raynor, personal communication, 1985). Agroforestry is the mixture of annual and perennial crops with forestry species and sometimes with animals. Pest control problems seldom arise in this system because of its stability and diversity. Further study into appropriate crop varieties and improved spacing and arrangement for intercropping of crops will not only keep pest populations in check, but increase food productivity as well.

Intercropping is attractive to small farmers because it diversifies their diets and their markets, thereby lowering their risks. It is, however, generally not amenable to mechanization and, like other traditional techniques, limits the plantation size to the amount and availability of labor. In addition, the development and application of technology to improve the efficiency of intercropping is not an easy task given the complexity of interactions in established cropping systems (American Society of Agronomy, 1979). However, the forces at work in polyculture intercropping which minimize pest infestation offer a basis for further research.

The use of the land for agricultural and other purposes in the U.S.-Affiliated Pacific Islands is intimitely connected to cultural and land tenure practices. Appendix 3 briefly describes some of these traditional influences on agriculture.

B. Chemical Pest Management generally refers to the use of synthetic organic pesticides. In the U.S.-Affiliated Pacific Islands the use of pesticides varies from little or no usage in subsistence areas to moderate usage on commercial farms. As in the United States, all pesticides used in the U.S.-Affiliated Pacific Islands must be registered with the Environmental Protection Agency (EPA). However, officials of the local EPAs and local Departments of Agriculture can unofficially decide which pesticides to prohibit from their islands due to environmental and health considerations (Faiiai, personal communication, 1985). The numbers of pesticides available on some of these islands between 1980-1984 are: American Samoa, 36; Guam, 107; the Trust Territories of the Pacific Islands, 375 (Mowbray, 1985). The availability of these pesticides does not indicate the quantities used. Very little accurate data is available on quantities used in most countries.

In American Samoa, pesticides are sold by the local Department of Agriculture at subsidized prices, and restricted-use pesticide purchasers must be trained by the Land Grant Program and certified by the Environmental Protection Agency. Training is conducted in both Samoan and English, but no provision is made in translating pesticide labels and instructions into Samoan. Since the directions for proper application procedures, safety and environmental precautions, accidental poisoning antidotes and other important information are located on the label, a non-English reader is at a great disadvantage. Possible misuse can have detrimental environmental and health effects and examples have been observed (Fatuesi, personal communication, 1985). Agricultural extension agents need to be aware of the inherent dangers in the use of pesticides and must carefully instruct clients in their proper useage. However, it would seem that labels in the appropriate local language would be the best precaution against misuse and would greatly assist the farmer.

A major deterrent to pesticide applicability in the U.S.-Affiliated Pacific Islands is that pesticides have been developed for large, technologically sophisticated monoculture farms conspicuously absent on most of these islands (Ennis, 1979).

Problems exist in regard to the obtainment and utilization of the correct pesticides on the islands. Selective pesticides, (those which specificially kill a given pest), as opposed to broad spectrum pesticides, (those which kill pests as well as nontarget and beneficial species), are generally expensive and difficult to obtain in these insular areas. Shipments of needed pesticides may take months to arrive. In addition, there are few studies to review effectiveness levels of pesticides in general, which are more subject to storage degradation under warm, moist, tropical conditions. Spraying equipment is also expensive and may be difficult to calibrate and to repair. Protective clothing may be unavailable, expen- sive and uncomfortable in the hot, humid climate of the islands, and proper storage and disposal of pesticides present special problems for the small farmer. The continual use of a particular pesticide can encourage the evolution of a resistant strain of the pest or may kill all the pest's natural enemies. Lastly, and of utmost importance, the fate of pesticides is largely unknown under the climatic and environmental conditions of the Pacific islands. Water quality analyses have detected minute quantities of Paraquat--a pesticide with a particularly strong affinity for soil particles and a cumulative poison--in several villages on American Samoa (Faiai, personal communication, 1985).

The environmental impacts of heavy reliance on chemical pesticides in the U.S.-Affiliated Pacific Islands has not been measured. However, pesticide use is widespread. They can be highly effective when marshalled with other pest management methods and they can be quickly enlisted to arrest damage in times of pest outbreaks. New practices for controlling soil erosion rely heavily upon pesticides (Wijewardene and Waidyanatha, 1984). Their usage to eliminate pests, such as fruit flies, on export crops would make these crops more acceptable to markets in Japan, the United States and elsewhere (Mark, 1982). Pesticides may also greatly enhance the exportability of crops by eliminating pest-caused blemishes. Some farmers believe pesticide use represents something modern and scientific and, therefore, worthy of emulation.

The effects of encouraging and further developing chemical technology must be carefully weighed. Most agriculturalists agree that pesticides have an important role in small farming. This role is further examined under section D, "Integrated Pest Management".

C. Biological Pest Management, or biological control, is the use of natural enemies to control pests. Biological control can also refer to the introduction of a predator, a pathogen or a parasite to control a pest. It occurs naturally in a balanced ecosystem where predator-prey relationships develop and are maintained by environmental checks (Smith, 1919). These agents include vertebrates, invertebrates and a wide variety of microbial pathogens, including bacteria, fungi and viruses. Many of these disease-producing agents are commercially formulated and are applied similarly to chemical pesticides. "Dipel", a commercialized formulation of *Bacillus thuringiensis*, is a caterpillar-controlling bacteria.

A biological control program begins with the identification of the pest. Next, a literature search discloses and documents natural enemies. If natural enemies are not available in the target area, outside exploration is required, preferably in the area of origin of the pest or where the climate and environmental conditions are similar to the affected area. Once promising natural enemies are located, they are subjected to in-depth studies in the field and in the laboratory to provide information on their host specificity, safety and culture methods. These extensive tests are necessary in order to ensure that the introduced biological control agent will not become a threat to non-target species or become a pest itself. Once the suitablitity of biological control agents are confirmed, they are further screened to eliminate disease and other unwanted contaminants, and then shipped to the infested area. The receiver may then subject the introduced predator or parasite to quarantine to make certain that no secondary parasites are inadvertently released. The biological controls are then introduced to infected areas and their success monitored. Mass rearing and continuous releases of the beneficial organisms are often attempted to further ensure successful establishment.

Unlike pesticides, biological controls are nontoxic, and in most cases are specific for the target pests. Furthermore, long-term exposure rarely results in resistance to the control. Of 253 projects reported up to 1970, 120 pest species had been successfully controlled by this method (Debach, 1974).

There is evidence that the level of success in a biological control introduction program is proportional to the amount of effort expended. Many failures of a biological control agent to become established may be merely the consequences of inappropriate methods or control agents (Greathead and Waage, 1983). Technical failure may be due to inadequate training of personnel, insufficient dedication to the task at hand, or inadequate facilities. Administrative failure stems from inadequate financial support and inability to realize the importance of speedy dispatch and effective use of biological control agents. (Tables 2 and 3 illustrate the success rate of biological control programs aimed at arthropod pests and weeds.)

The performance, or stability, of an agricultural system greatly affects the success of introductions for pest control. Long-term plantation crops provide good conditions for introductions by ensuring the continuity of both pest and control agent populations.

Biological control works best on long-standing crops such as trees, where the control agent has ample opportunity to become established. In the South Pacific, several pests of the coconut plam have been controlled by this method (German Agency for Technical Cooperation, et al., 1982). In 1984 in American Samoa, the coconut palm was severely threatened by the scale insect, *Aspidiotus destructor*. Predator ladybird beetles were introduced from Vanuatu and Hawaii. Within a year they had become successfully established and had dramatically reduced the pest population on this long-term crop. Another coconut pest in American Samoa, *Brontispa longissima*, is being controlled by a fungus, *Metarhizium anisoplie* and a complex of parasites.

More research into the effectiveness of biological control on short-term vegetable crop pests is needed. Vegetable producers generally produce a variety of crops, each with its own complex of pests. Several control agents may be necessary, and careful coordination with other pest management practices must be performed.

Biological control is of particular value when chemical control is either prohibitively expensive or over exploited and causing conditions of high pesticide resistance. It is appealing to the subsistence farmer because of its minimal interference with his existing mehtods. It requires no monetary or time input on his behalf other than monitoring for pests so that timely releases of the control organisms may be made.

The economics of this technology depends upon the level of information available. If a natural enemy is not listed in the literature, foreign exploration for one may be required. A prospective find is subjected to experiments for confirmational evidence and mass rearing requirements. Simple introduction of the biological control agent is the most economical practice since it incurs no recurrent costs. Mass production of biological controls for augmentive releases, however, may prove economically competitive with chemical methods in many crop systems (Greathead and Waage, 1983). On the average, the research and development costs to document a natural enemy is a few thousand dollars (Debach, 1974).

This cost is negligible compared to the millions of dollars spent on developing a singe pesticide. In California alone, savings in the reduced used of pesticides has amounted to over $200 million (ibid.). Table 4 illustrates the savings accrued from various biological control projects. In all cases costs of pesticides and environmental pollution are virtually eliminated by the adoption of biological control (Greathead and Waage, 1983). It is important to realize that in some situations, such as when immediate pest control is needed, it might be necessary to complement the use of biological controls with a minimal use of pesticides in an Integrated Pest Management (IPM) approach.

D. Integrated Pest Management (IPM) is the integration of all the above pest management strategies with consideration of economic, ecological and sociological consequences (Botrell, 1979). IPM maximizes the use of naturally occurring pest controls, including weather, disease agents, predators, parasites, resistant varieties and cultural practices. Pesticides are also used, but only after systematic monitoring of pest populations and natural control factors indicate a need (Flint and van den Bosch, 1981). Although an integrated control approach was originally addressed to insect problems, it is applicable to all classes of pests.

Development of a specific integrated pest management program requires an interdisciplinary systems approach.

In order to integrate the various IPM techniques into a cohesive scheme that will provide long-term benefits, collaborative efforts must be made by weed scientists, plant pathologists, entomologists, ecologists, agronomists, sociologists and computor systems specialists. Such expertise is necessary in order to collect appropriate information, formulate the IPM strategy, execute the strategy and evaluate the results.

The actual implementation of this well-defined technology in the small farming situation that is encountered in the U.S.-Affiliated Pacific Islands must be a modified version of this sophisticated "high-tech" approach. Extension agents, researchers at Land Grant institutions and farmers must work together to: evaluate presently used pest control measures; estimate disease incidence and insect pest abundance; decide whether levels of pest damage have reached economic threshhold levels; and decide what action is necessary at a given time. The key to the success of this type of IPM implementation is observation, education and implementation.

For example, in American Samoa coconut growers practice a traditional strategy against rhinocerous beetles by removing fallen trees from their plantations, thus eliminating breeding places for the beetle. A baculovirus can also be disseminated which specifically infects the beetle. If a rhinocerous beetle outbreak should occur despite these measures, pesticides may be discriminately used in those areas where needed and for the duration of the outbreak only. The overall effect is pest control at reduced cost for the farmer, safeguarding of the public health and minimized environmental impact.

A successful IPM program requires that farmers be informed and actively participate in its implementation. It raises their status from that of recipient of a service to that of partnership in pest control. World-wide, major IPM projects have been undertaken by the Food and Agricultural Organization of the United Nations (FAO) and the U.S. Agency for International Development (AID) to develop IPM systems in Asia and Africa.

E. Pest Eradication refers to the total elimination of a pest from an area. Attempts can be very costly with no assurance of success (Mitchell, personal communication, 1985).

One method of eradication is the Sterile Insect Release Method (SIRM) (Metcalf and Luckman, 1982). Enormous numbers of male pests are reared, sterilized and released to breed with normal wild females, who then lay infertile eggs. Sterility in males is induced either by exposure to ionizing radiation (e.g., from a cobalt source) or through translocation between chromosomes. SIRM may also be used in conjunction with insecticides, which initially decrease the pest population size.

SIRM is most successful on small insular areas because it is more feasible to manage a program and saturate a small area with irradiated insects. In addition, the problem is solved once the pest is eliminated, unless the pest is accidently introduced again. SIRM has been used successfully to eradicate the melon fly, *Dacus curcurbitae*, from the small island (33 square miles) of Rota. Irradiated flies were released at the rate of 9 million per week and eradication occurred within 6 months. SIRM has also been successful in eliminating the New World screwworm fly from parts of the Caribbean and the United States, and also from a zone across Northern Mexico.

However, failures do occur using this technique. Again, on Rota, the release of 10 million sterile males per week for 80 weeks failed to have much effect on the population of *Dacus dorsalis*, the Oriental fruit fly. It is interesting to note that the Oriental fruit fly was later eradicated in less than 8 months by means of a trapping technique combining a methyl eugenol lure with an insecticide. One suggested explaination for SIRM failures is that the irradiated flies are unable to successfully compete with wild males. Basic research into pest biology and behavior, as well as eradication techniques and methods of application, are pointedly essential in any pest suppression program.

Eradication programs for some pests may be viable options in many of the U.S.-Affiliated Pacific Islands, given their small size and location. However, this campaign requires sophisticated facilities coordinated and staffed by skilled professionals and technicians. To reduce the risk of reinfestation, the eradication project must be backed by a reliable and aggressive quarantine program. This includes adequate and operable facilities which are presently lacking in most cases. In addition, personnel must be trained in basic entomology and plant pathology so that they will be able to recognize and prevent entry of pests.

IV. Research on Pest Management Technology

Research is being conducted at several institutions in the U.S.-Affiliated Pacific Islands, stressing the development of various pest management technologies.

A. University of Guam (Guam Agricultural Experiment Station Annual Report, 1983, 1982, 1981; Schreiner, personal communication, 1985; Muniappan, personal communication, 1985).

1. Biological Control Projects
    - a. Evaluation of the parasitoid (Anagyrus indicus) for the control of the spherical mealybug (Nipaecoccus vastator).

b. Control of the spiraling whitefly (Aleurodicus dispersus).

c. Importation, mass-rearing and release of biological control agents against several insect pests. Researchers have supplied control agents to American Samoa, Kosrae, Saipan, the Phillipines, Japan and Taiwan.

d. Joint biological control projects with India.

e. Promoting biological control in Guam and other U.S.-Affiliated Pacific Islands in Micronesia through consultation and distribution of appropriate biological controls.

f. A biological control quarantine facility has been recently built and approved by the U.S. Department of Agriculture.

2. Chemical Pest Management Projects

   a. Control of the mango shoot moth (Bombotelia jacosatrix).

   b. Control of the mango leaf beetle (Phytorus lineolatus).

   c. Control of Liriomyza trifolii on yardlong bean.

   d. Degradation of Diazinon under field and greenhouse conditions.

   e. Fate of pesticides on Guam.

3. Integrated Pest Management Projects
    a. Control of *Liriomyza* spp. leafminers and *Thrips palmi* on various fruit and vegetable crops.
    b. Control of the mango leaf caterpillar (*Bombotelia jacosatrix*).
    c. Control of the Oriental maize borer on corn in Micronesia.
    d. Development of a Micronesian Tropical Agriculture data base.

B. American Samoa Community College (Navarro, personal communication, 1986 and Vargo, personal observation).
1. Traditional Pest Management Projects
    a. Survey of pests and their damage in traditional cropping schemes.
    b. Control of the taro armyworm by intercropping taro with *Coleus blumei*.
2. Biological Control Projects
    a. Identification of pests and their natural enemies on traditional crops and introduced fruit and vegetable crops.
    b. Control of *Brontispa longissima* on coconut palm using *Metarhizium anisopliae* and *Tetraasticus brontispae*.
    c. Population dynamics of taro planthopper (*Tarophagus proserpina*) and its mirid predator, *Cyrtorhinus* spp. in a newly planted taro plantation.

3. Chemical Pest Management Project

   Comparison of Benlate and Calyxin on the suppression of leafspot disease on banana.

4. Integrated Pest Management Projects
   - a. Development of IPM in American Samoa.
   - b. Control of Thrips palmi on cucumber, possibly in a joint Section 406 of the Food for Peace Project Proposal with the Universities of Hawaii and Guam.
   - c. Crop variety trials.

C. Ponape Agriculture and Trade School

The school's terraced 20 acre farm is a research and a demonstration project in agroforestry. Sweet potatoes, corn and beans are intercropped with citrus, avocado, breadfruit and banana in order to stabilize the terraces. Within the past 3 years soursop, guava, betel nut, papaya, coconut, cashew, monkeypod, mango, Polynesian chestnut and several varieties of Leuceaena leucocephala trees have been planted on terraces and along fence borders.

Inspired by the concept of permaculture, a demonstration project has combined the growing of 3 types of taro (Cyrtosperma spp., Xanthosoma spp. and Colocasia spp.) with Hibiscus spp., Barringtonia racemosa, Kang kang, Polynesian chestnut and betel nut.

To date, no pest infestation data is available. The successful establishment of such an ambitious project, however, suggests that natural pest control forces are at work. Research into the nature of these forces would seem promising.

D. University of Hawaii/Hawaiian Department of Agriculture

The University of Hawaii conducts pest management research which benefits the U.S.-Affiliated Pacific Islands. Several joint IPM projects are currently in progress with Guam and American Samoa.

The Hawaiian Department of Agriculture has been instrumental in supplying biological control agents to Guam and American Samoa. Its taxonomic service has been invaluable in the identification of pest specimens sent from Guam and American Samoa.

E. Several Pacific Area Research Centers conduct research on various pest management technologies:

1. Vaini Research Station, Kingdom of Tonga.
2. Koronivia, Sigatoka and Lautoka Research Stations, Fiji.
3. Nu'u Crop Development Station, Western Samoa.
4. University of the South Pacific, Alafua Campus, Western Samoa.
5. Centre ORSTOM de Tahiti, Tahiti.
6. Australian Centre for International Agricultural Research, Australia.
7. Commonwealth Scientific and Industrial Research Organization, Australia.
8. Mount Albert Research Centre, New Zealand.

Information exchange and research coordination are important prerequisites in the development of pest management technologies in the Pacific Basin. Until mid-1985, the PeaceSat communication satellite offered a means of immediate consultation with area experts. Due to technical difficulties this service is no longer available. Reestablishment of this network, along with an information retrieval system, should receive priority consideration.

The funds allocated by Section 406 (the Matsunaga Amendment) of the 1966 Food for Peace Act must be increased to keep pace with the additional research programs and personnel it supports. At present, the University of Hawaii's College of Tropical Agriculture and Human Resources (CTAHR) has been designated as the Pacific Basin Center for Tropical and Subtropical Research (Mark, 1982), and has qualified for Section 406 research funds. However, with the expansion of Land Grant status to institutions in Guam, American Samoa and Micronesia, additional Section 406 funds need to be allocated and made available to these research centers.

The agroforestry demonstration project in Ponape and research centers in Micronesia are seriously understaffed. The present number of personnel do not adequately reflect the scope and diversity of these regions and provision for appropriate staff increases should be made (Raynor, personal communication, 1985).

V. Summary of Opportunities and Constraints for Pest Management

A. Traditional Pest Management Technology

1. Opportunities
    a. Already in practice.
    b. Low input requirements.
2. Constraints
    a. Labor intensive.
    b. Research needed to improve efficiency.

B. Chemical Pest Management Technology

1. Opportunities
    a. Fast and effective results.
    b. Regarded as "status symbol" or scientific farming.
    c. Equipment can spray several types of pesticide.
2. Constraints
    a. Requires equipment expenditures.
    b. Requires dependable supply of pesticides and storage facilities.
    c. Toxic to the user and the environment.
    d. Protective clothing is either impractical, unobtainable or expensive.
    e. Effectiveness, biodegradability, persistance and establishment of safe residue levels are all unknown or little understood for the tropics.
    f. Pests can develop resistance.
    g. Labels not in local language.

C. Biological Pest Management Technology

  1. Opportunities

    a. Nontoxic.

    b. Inexpensive and least disruptive for farmer.

    c. Already established for some pests.

    d. Readily available for some pests.

    e. Once established, success rate generally high.

  2. Constraints

    a. Requires literature search capabilities.

    b. Requires mass-rearing facilities.

D. Integrated Pest Management Technology

  1. Opportunities

    a. Stresses cost effectiveness through minimal use of pesticides.

    b. Since IPM encompasses all pest management strategies, all opportunities listed above apply.

  2. Constraints

    a. Requires multidisciplinary staff.

    b. All constraints listed above apply.

VI. Constraints to Agriculture in General (Mark, 1982)

The development of Pest Management Technologies is largely dependent upon the development of agriculture itself. Listed below are some of the constraints for agricultural development, in general, throughout the U.S.-Affiliated Pacific Islands:

1. Cultural
    a. Preference for imported processed foods.
    b. Low status of farmer.
2. Geographical
    a. Remoteness from export markets.
    b. Steep topography of some islands.
    c. Inadequate rainfall of some islands.
3. Economical
    a. USDA food programs where free or below-cost foods deter desire for self-sufficiency.
    b. Low agricultural prices and high agricultural wages.
    c. Domestic market problems such as substandard processing, grading, packaging, pricing and distribution.
    d. Restrictions on foreign investments due to land ownership laws.
    e. Export market problems such as import restrictions and requirements, seasonal demand and transportation costs.
    f. Difficulty in obtaining credit.
4. Legislative
    a. Weak local government support for agriculture.
    b. Infrastructure limitation such as roads, power, water and storage, processing and harbor facilities.

c. Inadequate training and research facilities.

d. Inadequate farm services such as seed, feed, fertilizer and pesticide supplies; lack of technical expertise and veterinary service.

VII. Objectives for Congressional Action to Facilitate Development of Pest Management Technologies

Appropriate pest management practices are essential to the enhancement of agricultural production in the U.S.-Affiliated Pacific Islands. An Integrated Pest Management approach, with its emphasis on a systems approach to pest management as well as environmental safety, offers the most acceptable option. In order to best implement its development, Congressional action should first focus on one aspect of IPM that most urgently needs attention--pesticide use. Despite environmental hazards pesticide usage will continue because of its "magic bullet" reputation. Therefore, steps should be taken to assure that pesticide misuse is at a minimum. Several regional projects have been proposed but have not been funded. Because the U.S.-Affiliated Pacific Islands are a part of the Pacific region and tremendously influenced by regional trends, Congress should seriously consider funding for the outlined projects. (Recommendations are ranked by priority in each subsection.)

A. Support Regional Projects

1. There are over 589 pesticides used in the South Pacific, many of which are banned elsewhere or are regarded as extremely hazardous by the World Health Organization (Mowbry, submitted for publication). Very little is known regarding the fate of pesticides in small island ecosystems. To deal with the problem of pesticide misuse, Mowbry suggests the creation of the following:

    a. Pesticide Information Center to:

        i. Collate and compile data on pesticides used in the region, and create a "register" for the South Pacific.

        ii. Provide a library service and maintain a bibliography of articles on pesticide use and associated problems in the region.

        iii. Provide individual countries and territories with technical information as required.

    b. Regional Pesticide Advisory Committee to:

        i. Provide a "collective expertise" using persons from within the region.

        ii. Recommend to regional countries and territories what pesticides should be registered or used, for what crops, etc..

        iii. Establish guidelines for harmonization of pesticide registration requirements and for suggesting other forms of controlling pesticide use in the region.

c. Regional Pesticide Residue Laboratory Network to perform small-scale monitoring of pesticide residues. Studies would involve water supplies, agricultural products, environmental samples, human tissues and checking formulations.

   Manpower and funds are currently lacking to effectually establish any of these three recommendations. Considering the severe threat posed by some pesticides in this area and the consequences of their misuse, support for these recommendations should receive high priority.

2. Formation of an Information Retrieval System. The South Pacific Commission (SPC) has been instrumental in the dissemination of technical information vital to research and extension personnel. The SPC is presently considering the formation of an information retrieval system that would promote and expedite the availability of this information, but it lacks sufficient funds (Ikin, personal communication, 1985; Maddison, personal communication, 1985). Joint funding with an United States agency would benefit every member of the U.S.-Affliated Pacific Islands as well as most Pacific Island nations.

3. Partial funding of Dr. Peter Maddison's 20,000 page opus on insects of the South Pacific. Dr. Maddison, an entomologist with the Department of Scientific and Industrial Research in Auckland, New Zealand, has compiled a monumental work on insect pest identification for this region. The SPC has funds enough to publish only 30 copies of this set. Additional funding would make sets of this valuable reference available to more research and technical personnel.

B. Support Research and Educational Programs

1. Effective quarantine has been cited as an important deterent to pest infestations. Training of quarantine personnel to recognize and handle pest threats is an urgent need. Training workshops for extension agents and local farmers, that provide "hands on" experience, is also important for immediate impact.
2. Increase funding to agencies that promote pest management and related research such as:
    a. The United States Department of Agriculture. Grant proposals from the U.S.-Affiliated Pacific Islands are often rejected because it is felt that their research will not benefit agriculture in the continental United States. While this may be true in some cases, the uniqueness of the tropical situation should be realized and special funds allocated for research in these areas since a great poten-

tial exists to contribute to the advancement of regional Pacific agriculture.

   b. Section 406 of the Food for Peace Act, which deals with agricultural research in the Pacific Basin. As discussed earlier, the number of institutions involved in the Pacific Basin have increased and research potential has expanded. Consequently, the need exists for additional supportive funds.

3. Support funding for training programs or educational opportunities geared to upgrade or expand the capabilities of the limited number of professional staff.

C. Allocate funds for such pest management facilities as:

1. Quarantine facilities. Trained personnel and functional equipment, such as fumigation chambers, are lacking or inadequate on most islands. A program to upgrade personnel and facilities would be extremely beneficial.
2. Biological control laboratories, complete with greenhouses and insectaries to contain, isolate, mass-rear and study the biology of pests and their control agents.

D. Support the Coordination of Regional Efforts

Promote the establishment of a regional cooperative pest management board or laison officer to coordinate the development of all the above-mentioned pest management technologies for the territories. This cooperative effort could extend to the South Pacific Commission, Food and Agricultural Organization of the United Nations, U.S. Agency for International Development, Commonwealth Scientific and Industrial Research Organization and the Commonwealth Agricultural Bureaux International. This effort would best prevent duplication of efforts as well as prioritize regional needs.

VIII. Application of Legislation to Development of Pest Management Technologies

A. The Environmental Protection Agency (EPA) regulates the registration of pesticides. Several aspects of these regulations need special consideration when applied to the U.S.-Affiliated Pacific Islands.

1. In American Samoa many farmers who wish to use pesticides are not fluent in English, the language in which pesticide labels are printed. EPA regulations prohibit the altering of pesticide labels, even to the extent of translating the label into the local language. New Zealand chemical companies, however, manufacture pesticides with local language labels. But these pesticides are not registered with the U.S. EPA and, therefore, are unavailable to the territory's farmers. It is suggested that legislation be formulated to modify this EPA regulation so that local language labels, either on approved U.S.-manufactured

pesticides or foreign-manufactured pesticides which meet local EPA approval, be made available to U.S.-Affiliated Pacific Islands farmers.

2. The EPA specifies that a pesticide may only be used against certain pests on certain crops listed on its label. This list often neglects pests and crops found in the tropics, so a Special Local Needs Label must be obtained. The requirements to obtain this label require extensive research and residue analyses, and the cost in time may be prohibitively high given the limited size of staff and facilities on the islands. These studies, however, may have been performed by and for neighboring nations. It is suggested that research results from these other studies be applicable for obtaining a Special Local Needs Label.
3. The EPA should examine ways to accelerate the registration process for methods of pest control proposed for Integrated Pest Management systems, such as pest disease agents and insect pheromones, and should sponsor needed developmental research leading to their registration.

B. Extend programs under the auspices of the U.S. Department of Agriculture (USDA) and other agencies that further the development of agriculture to the Territories. Under the Omnibus Territorial Act of 1980, the Secretary of Agriculture can extend and provide funds for USDA programs in the Territories at his discretion.

C. Treat the Territories as a group when extending programs and funds, allowing the local administration the option to participate (Sunia, personal communication, 1985). Presently, American Samoa is excluded from Federal assistance, which the Commonweath of the Northern Mariana Islands and Guam receive, to promote agricultural development (ibid.).

D. Withdraw or modify the matching-funds stipulation for Land Grant Institutions. The establishment of Land Grant Programs in Guam, American Samoa and Micronesia has indirectly benefitted the development of pest management technologies in the U.S.-Affiliated Pacific Islands by supporting programs in pest management. Land Grant Programs are mandated by three pieces of Federal legislation which fund the Land Grant Institutions: the Morrill Act of 1862, the Hatch Act of 1887 and the Smith Lever Act of 1914 (Land Grant Programs 1985). A portion of the funds is provided as match-free grants. However, a substantial amount of funding is granted only if matching funds are provided by local sources. This stipulation is difficult to meet because sources of matching funds are almost nonexistant in the territories. The withdrawal or modification of this stipulation would permit more funds to become available for the development of pest management technologies in the U.S.-Affiliated Pacific Islands.

D. Make provision when granting funds that the money be used exclusively for the purposes listed in the grant proposal. This can best be assured by directing the funds to the researcher or his immediate supervisor. Oftentimes, grant money is directed to a local government's general fund where retrieval can be time-consuming or fruitless.

E. Several local laws in American Samoa, through their encouragement of cultural methods, promote Integrated Pest Managment (American Samoa Code Annotated, 1973).

   1. Rhinocerous Beetle Law: "Every person who owns land shall keep the land free and clear of rotten wood, decayed logs and other potential breeding places." Whenever outbreaks occur every able-bodied man 18 years old and older, who is not at work, must spend every Wednesday searching and collecting the Rhinocerous beetle.

   2. Bunchy Top Law: All banana plants infested by the bunchy top virus must be destroyed and the plantation quarantined.

   Local governing bodies should be encouraged to implement pest management strategies with legislation.

IX. Additional Opportunities to Promote the Application and Development of Pest Management Technologies

In addition to the proposed strategies of promoting Pest Management Technologies offered in the above section, several other aspects need consideration:

A. Congressional funding for pest eradication

Some attempts at pest eradication have been successful, yet no U.S. Department of Agriculture funds are available for this purpose (Schreiner, personal communication, 1985). Federal funding should be channeled toward this purpose where the potential for eradication is high and the benefits substantial.

B. Involvement in AID and FAO projects

The U.S. Agency for International Development (AID) and the United Nations Food and Agricultural Organization (FAO) are active in supporting agricultural projects in developing countries. In many cases, the research undertaken by these organizations is directly applicable to the development of agriculture in the U.S.-Affiliated Pacific Islands. For example Western Samoa, only 90 miles from American Samoa, benefits from several AID and FAO projects with funding and expertise from the United States and elsewhere. However, American Samoa receives no benefit from this research--not even communications concerning intended projects or results of research. In short, Americans are not benefitting by American financed research. In addition, the U.S.-Affiliated Pacific Islands, with the exception of the Federated States of Micronesia, do not qualify for any assistance from either AID or FAO due to their close association with the United States (Sunia, personal communication, 1985). With the possible exception of Guam, none of these islands can be considered "developed", and should therefore be included in programs promoted by these organizations.

C. Uniqueness of tropical environment

The U.S.-Affiliated Pacific Islands offer ecologists, biologists and other researchers a unique environment for study. This may appeal to universities, foundations and research institutions to promote basic research that may have application to the development of pest management technologies.

D. Scholarships for agricultural training

In order to promote interest in the pest management aspect of agriculture, scholarships should be offered to and potential job opportunities identified for students. The continued implementation of pest management strategies will rely upon trained and capable researchers, extension agents and other support staff. An investment now can insure future success.

X. Concluding Remarks

The U.S.-Affiliated Pacific Islands are in the unique position of being able to make regional contributions in pest management as well as in environmental preservation and human safety.

Pesticide usage is widespread throughout the Pacific tropics. However, there is no advisory or regulatory board responsible for protecting and educating the consumers or for sponsoring research to evaluate the effectiveness and fate of pesticides under tropical conditions. The Pacific area has become a dumping ground for many hazardous pesticides banned in developed countries. Because the region is composed of many small independent countries, most being without resources for pesticide regulation or research, there is also widespread misuse and illegal importation or exchange of pesticides between neighboring islands.

A program to establish a regional pesticide advisory or regulatory committee, as put forth by Mowbry, is warranted. In addition to pesticide regulation, the project can also be expanded to include research into the promotion of various aspects of IPM, such as traditional cropping schemes and employment of biological control agents.

The benefits of regional cooperation are exemplified by the success of the Baculovirus project during the 1960's and 1970's to control the Rhinocerous beetle on the coconut palm. This pest is now under control due to the cooperative efforts of researchers worldwide.

Strengthening quarantine would have the greatest impact on pest management and crop protection for the U.S.-Affiliated Pacific Islands since emphasis placed on prevention rather than treatment is economically more sound. The infrastructural agencies (i.e., the local Departments of Agriculture) already exist, though facilities and personnel capabilities must be upgraded.

The necessity of an information retrieval and communications system cannot be over emphasized since it is central in the development of all pest management technologies. In addition social, economic and cultural factors must be weighed, and educational and research opportunities must be supported in order to develop and sustain effective technologies.

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Table I: AGRICULTURAL PESTS OF SOME U.S.-AFFILIATED PACIFIC ISLANDS

A. American Samoa

Crop	Pest	% Loss	Control
Cocos nucifera	*Oryctes rhinoceros*	20	*Baculovirus oryctes*
	Aspidiotus destructor	25	*Aphytis spp.* *Chilocorus spp.*
	Brontispa longissima	20	*Metarhizium anisopliae* *Tetrasticus brontispae*
	Graeffea crouanii	5	Applying smoke to folage
	Mikania micrantha		Slashing/Paraquat
	Mimosa pudica		Slashing/Paraquat
	Nephrolepis hirsutula		Slashing/Paraquat
	Paspalum conjugatum		Slashing/Paraquat
	Ruellia prostrata		Slashing/Paraquat
Musa spp.	Bunchy Top Virus	25	Burning of plant
	Mycospharerella spp.	10	
	Cosmopolites sordidus	5	
	Lamprosema octasema	25	
	Mikania micrantha		Slashing/Paraquat
	Paspalum conjugatum		Slashing/Paraquat
Colocasia esculentum	*Spodoptera litura*	10	*Apanteles spp.* *Chilonius spp.* Dipel
	Tarophagus proserpina	10	*Cyrtorhinus fulius*
	Mikania micrantha		Slashing/Paraquat
	Paspalum conjugatum		Slashing/Paraquat
Lycopersicon esculentum	*Chrysodeixis eriosoma*		
Cucumis sativus	*Thrips palmi*	100	
Brassica spp.	*Plutella xylostella*	25	Dipel *Bacillus thuringinsis*
	Achatina fulica		*Gonaxis kibwcziensis* *Euglandina rosea*
	Echinochloa colona		Hand weeding
	Eleusine indica		Hand weeding

B. Truk

Musa spp.	*Cosmopolites sordidus*	15	
Colocasia esculenta	*Phytophthora colocasiae*		
	Papuana spp.	15	

Crop	Pest	% Loss	Control
Artocarpus communis	*Icerya purchasi*	50	
Ipomoea batatas	*Elsinoe batatas*	15	Planting pest-free stock
C. *Kosrae*			
Citrus spp.	*Aleurocanthus spiniferus*	90	*Prospatella smithii*
Cucumis sativus	*Aphis gossypii*		
Solanum melongena	*Tetranychus cinnabarinus*		
D. *Ponape*			
Cocos nucifera	*Rattus rattus*, *R. exulans*		Metal banding and Poison baits
Musa spp.	*Mycosphaerella musicola*	30	Light oil spray
Colocasia esculenta	*Tarophagus proserpina* *Phytophthora colocasiae* *Pythium spp.*	30	*Cyrtorhinus fulius*
Ipomoea batatas	*Elsinoe batalas*	50	Pest-free planting stock and crop rotation
	Cassida spp.	30	
E. *Guam*			
Cocos nucifera	*Brontispa longissima*		*Tetrasticus brontispae*
Musa spp.	*Erionota thrax*		*Bacillus thuringiensis* *Apanteles spp.*
Citrus spp.	*Aleurothrixus floccosus* *Trialeurodes spp.*		
Psidium guajava	*Aleurothrixus floccosus* *Aleuiodicus dispersus*		
Cucumis sativus	*Aulocophora simmilus*		
Brassica spp.	*Heliothis spp.* *Plutella xylostella* *Crocodolomia binotalis*		
Phaseolus spp.	*Ophiomyia phasiolae* *Liriomyza trifolii*		

Crop	Pest	% Loss	Control
Citrullus vulgaris	*Thrips palmi* *Aphis gossypii*		
Zea mays	*Adoretus* spp. *Ostrinia furnacalis*		

TABLE 2: BIOLOGICAL CONTROL OF INSECTS ON VARIOUS CROPS

Crop		Number of pests (1) Attempted	Succeeded
CEREALS	wheat and barley	5	2
	rice	7	3
	millet	9	3
ROOT CROPS	sweet potato	1	1
	cassava	1	0
GRAIN LEGUMES	beans, cowpea, soya	11	6
OIL SEEDS	groundnut	1	0
	castor	1	0
PLANTATION CROPS	sugarcane	28	14
	coffee arabica	8	4
	tea	1	1
	cacao	2	1
	coconut	21	11
	tobacco	1	0
VEGETABLES	tomato, onion, etc.	14	4
	brassicas	5	1
	potato	2	1
FRUITS	banana	3	2
	pineapple	1	1
	citrus	39	24
	apple	6	3
	date	1	1
FORAGE	lucerne	6	3
	pastures	11	5

(1) The number of species of insect pests against which "classical" biological control has been attempted and the number of species which have been successfully controlled in at least one location. From Greathead and Waage, 1983.

TABLE 3: BIOLOGICAL CONTROL OF WEEDS TO 1979 (1)

	Totals	Number of Weed Species
Attempts	147	85
Successes	49	19
Unquantified		
pending	34	
no record	20	

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(1) Julien, M.H. (ed.) 1982. Biological control of weeds: A world of agents and their target weeds. Commonwealth Agricultural Bureaux, Slough, in Greathead and Waage, 1983.

TABLE 4: SOME ESTIMATES OF BENEFITS ACCRUING FROM BIOLOGICAL CONTROL

A. California 1923-59 from DeBach (1964)

Pest (date controlled)	Total Savings over previous losses plus pest control cost in $US
Citophilus mealybug (1930)	56,000,000
Black scale (1940)	32,000,000
Klamath weed (1953)	20,900,000
Grape leaf skeletoniser (1949)	750,000
Spotted alfalfa aphid (1958)	5,600,000
Total savings on 5 projects:	115,300,000
Total spent over period:	4,300,000

B. Australia projected to 2,000 AD at 1975 values discounted at 10% (1)

Pest	Cost of research by CSIRO (Equiv) $A-million	$US	Total benefits (Equiv) $A-million	$US
Skeleton weed	2.39	3.13	264.4	346.41
Wood wasp	6.27	8.21	15.4	20.17
White wax scale	1.07	1.40	1.7	2.22
Two-spotted mite	0.67	0.88	17.5	22.92
Red scale	not	available	17.7	23.19

C. Benefits of some tropical CIBC projects as supplied by sponsors (2)

Pest	Country	Total cost $US	Benefit (year) $US
Rufous scale	Peru	1,789.14	226,916 saved on chemical control (1977)
Barnacle scale	Hawaii	--	110,000 increased yield (1974)
Sugarcane scale	Tanzania	11,975.88	67,832 increased yield (1974)
Sugarcane borer	Brazil	9.54/ha	48.15/ha (1979)
Coconut leafminer	Sri Lanka	35,782.95	12.4 million in crop saved (1977)
Potato tuber moth	Zambia	35,731.66	547,560 gain discounted from 1974 to 1980 (1974)

(1) Marsden J.S. et al. (1980). "Returns on Australian agricultural research", Commonwealth Scientific and Industrial Research Organization (CSIRO), Canberra.

(2) Original costs and benefits figures in Pound Sterling converted to $US using IMF Exchange Rates Statistics.

APPENDIX 1 PEST MANAGEMENT SURVEY

Your country: ____________________

Your name and title ____________________

PEST MANAGEMENT QUESTIONNAIRE

I. List the major food and fiber crops that are grown on your island (s). Indicate the percent used for local consumption and for export.

CROP	% Local Consumption	% Export

II. List the major pests for each crop. Please complete a pest survey form (see attachments) for each pest. State scientific names, if known. Use back of paper if needed.

CROP	MAJOR PESTS

III. Can you suggest laws or regulations that would help [illegible] methods to control these pests. Are there any policies, programs or regulations that prevent the development of these methods? State if the law or policy is of local; Federal or International origin.

IV. How would you spend U.S. government money to control these pests or develop methods to control these pests? For example, hire more extension agents, build/supply research facilities, assist in developing regional cooperative strategies, improve quarantine facilities.

PEST SURVEY FORM - Complete one for each pest listed.

Please fill in or check the appropriate blanks. If the information is not available, write NA in the blank provided.

Crop________________________ Pest________________________

PART I

______ 1. Percent of farmland growing this crop.

______ 2. Percent of farmers growing this crop.

______ 3. Percent of these farmers affected by the pest.

______ 4. Percent of crop lost to pest.

______ 5. Dollar loss.

______ 6. Where does damage occur? (Field -F, Storage-S, Both-FS)

______ 7. What year did this pest become a problem in your area?

______ 8. Is the pest newly introduced (N): endemic but just reaching pest level (E): or an old established pest (O). If newly introduced, do you know where from?____________________.

PART II

1. Indicate what percent of farmers use the following methods to control the pest:

______ No control.

______ Traditional cultural practices (Briefly describe on bottom or back of page).

______ Intercropping. (What crops________________________________.

______ Resistant crop varieties.

______ Biological control. (Describe on back).

______ Pesticides-Chemical control.

______ A well-defined integrated pest management (IPM) program.

2. Is research being done on your island (s) to control the pest. If yes, briefly describe and include reference research reports or reprints of journal articles, if available.

APPENDIX 2

Survey Response

Survey forms could not be reproduced, thus, appendix 2 is not included.

Appendix 3: Influence of Customs on Agriculture

In American Samoa, the traditional lifestyle ("Fa'a Samoa") emphasizes the achievements of the family or group ("aiga") rather than the individual. A chief ("matai") protects and distributes family lands, manages the group's economy and represents the group in councils. Since a chief's status is closely linked to his lands, 92% of all American Samoa land is still owned by families (Office of Coast Zone Management and Office of Development and Planning, ca. 1981). Similar systems exist throughout Micronesia.

In Palau, land is owned by the "blai", a subdivision of a clan. The chief's duties are comparable to those of the Samoan matai's (Barrau, 1961).

In the Marshall islands most land is held by matrilineages and land rights are accorded by one's position within or relationship to the lineage. Narrow 2-5 acre strips extend from the ocean to the lagoon side of elongate islets.

Matrilineal groups and individuals own land in Truk, and ownership can pass between these two categories. Ownership can be divided within a single tree, with branches having separate owners.

The landholding group in Yap is the "tabinaw", which is also the term for a family estate. Because of depopulation a single group may hold several estates.

In Ponape the "nanmarki" is titular landowner in each district, with sections being assigned to subchiefs (McGrath and Scott, 1971). Spanish, German, Japanese and American influences have affected land ownership in Micronesia to varying degrees.

In the Trust Territories, land is very scarce and its use in an economic sense is negligible compared to the social and political status derived from holding the land use rights (Mark, 1982). Food crops have traditionally been cultivated to gratify family needs rather than serve as a source of income.

In Guam, 48.4% of the land is privately owned, while the U.S. Military holds 31.4% and the Federal and Guam Governments share the remaining 20.8% (Ziehmn, 1979). Traditionally, land ownership has been highly valued by the Chamorros. To keep the land in the family, parcels have been subdivided among members with a high frequency of multiple ownership of single parcels (Mark, 1982). Commercial mechanized truck gardens supply the local market. The only vestige of subsistence farming is the family vegetable plot. Few people clear land by hand, and rototillers and tractors are widely used (Schreiner, personal communication, 1985).

The clan system with communal ownership of land, prevalent in American Samoa and Micronesia, presents a difficult problem to agricultural development. The system often ignores the profit motive because of family tendencies to completely share produce before it reaches the market. This practice discourages a farmer who needs profit to reinvest in fertilizers, pesticides and other capital. Another problem is that communal ownership and family consensus for use of all land may also make it difficult to obtain land for farming.

Except for Guam, most of the agriculture in the U.S.-Affiliated Pacific Islands is done manually. Traditional methods have evolved for each culture concerned, but those of American Samoa and Ponape can serve to illustrate these traditional methods:

In American Samoa, plantations for taro, coconut, banana and breadfruit are cleared from forest land by cutting the trees and allowing them to decompose for a year. About one acre is cut at any time (Fatuesi, personal communication, 1985). The area is then slashed and planted through the mat of decaying weeds by young men using a pointed digging stick ("oso") and a rounded-end stick ("oso to") (Barau, 1961).

Weeding is done manually by women on Saturdays while visiting the plantation to gather food for the Sunday feast. Any surplus, including blemished produce, can be sold locally.

In Ponape, traditional agroforestry begins with the construction of a house ("ihmw"), clearing around its perimeter and planting this area with banana. Further land preparation extends the perimeter and is restricted to slashing of the underbrush and planting banana, coconut, breadfruit, yam and medicinal plants. This may take several years.

The machete is the primary agricultural tool. Fertilizer is not generally applied to the tree crops, but a compost of grass leaves is used on yam. Taboos and magic still exert their influences on the planting and growing of crops (Raynor, submitted for publication).

Land Tenure Characteristics
(in acres)

	1976 Guam	TTPI	CNMI	Belau	Yap	Truk	Ponape	Kosrae	Marshalls	Am. Samoa
Private Ownership	10,038	78,814	13,725	11,863	11,640	9,843	9,847	4,459	17,437	6,500
Homestead	n.a.	2,573	1,452	-	-	-	1,121	-	-	
Religious	n.a.	467	93	11	16	27	279	1	40	1,000
Public Lands	n.a.	14,413	9,346	4,659	98	16	294	-	-	1,500
Leased Lands	n.a.	24,295	15,941	1,764	2	325	6,233	30	-	
Public Domain	n.a.	131,245	75,789	27,559	367	1,541	19,378	6,142	469	
Misc.	n.a.	668	n.a.	144	1	n.a.	523	-	-	500
Federal	44,507	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Communally-Owned	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	33,500

n.a. = not available

Sources: Guam Economic Development Master Plan
1977 Annual Report to U.N.
Annual Report of Governor of Am. Samoa

APPENDIX 4: COMPREHENSIVE LISTING OF THE PESTS OF U.S. AFFILIATED PACIFIC ISLANDS--submitted by survey respondents.

LIST OF PRINCIPAL CROPS AND THEIR PESTS
of Northern Mariana Islands

CROPS	PESTS	
	COMMON NAME	SCIENTIFIC NAME
1. BANANA	Banana root borer	*Cosmopolites sordidus*
	Chinese rose beetle	*Adoretus sinicus*
	Banana skipper	*Erionata thrax*
	Banana aphid	*Pentalonia nigronervosa*
	Cotton aphid	*Aphis gossypii*
	Locust	*Valanga excavata*
	Mindanao june beetle	*Holotrichia mindanaoana*
	Fluted scale	*Icerya aegyptiaca*
	Cluster caterpillar	*Spodoptera litura*
	Passion fruit vine bug	*Leptoglossus australis*
	Mealybug	*Pseudococcus orchidicola*
	Banana corm weevil	*Polytus mellerborgi*
	Planthopper	*Proutista moesta*
	Weevils	*Trigonops* sp.
2. BEANS	Serpentine leafminer	*Liriomyza brassicae*
	Leafminer	*Acrocercops* sp.
	Cowpea aphid	*Aphis craccivora*
	Chinese rose beetle	*Adoretus sinicus*
	Green garden looper	*Chrysodeixis chalcites*
	Bean pod borer	*Maruca testulalis*
	Limabean pod borer	*Etiella zinckenella*
	Litchi fruit moth	*Crytophlebia ombrodetta*
	Cluster caterpillar	*Spodoptera litura*
	Common black garden fleahopper	*Halticus tibialis*
	Southern green stink bug	*Nezara viridula*
	Black stink bug	*Coptosoma xanthogramma*
	Pacific black stink bug	*Brachyplatys insularis*
	Philippine katydid	*Phaneroptera furcifera*
	Green leafhopper	*Empoasca pitiensis*
	Broad mite	*Polyphagotarsonemus latus*
	Bean fly	*Ophiomyia phaseoli*
	Whitefly	*Bemisia gossypiperda*
	Passion fruit vine bug	*Leptoglossus australis*
	Bean leafroller	*Nacoleia diemanalis*
	Darkling beetle	*Gonocephalus* sp.
	Bean butterfly	*Lampides boeticus*
	Treehopper	*Leptocentrus taurus*
	Onion thrip	*Thrips tabaci*
	Spider mite	*Tetranychus* sp.

	[illegible]	[illegible]
	Diamond back moth	Plutella [illegible]
	Gregarious cabbage moth	Crocidolomia binotalis
	Corn earworm	Heliothis zea
	Cluster caterpillar	Spodoptera litura
	Philippine katydid	Phaneroptera furcifera
	Common black garden fleahopper	Halticus tibialis
	Serpentine leafminer	Liriomyza brassicae
	Chinese rose beetle	Adoretus sinicus
	Whitefly	Bemisia gosspyperda
	Cotton aphid	Aphis gossypii
	Green peach aphid	Myzus persicae
	Turnip aphid	Hyadaphis pseudobrassi
	Onion thrip	Thrips tabaci
4. CITRUS	Citrus swallowtail	Papilio polytus
	Orange piercing moth	Othreis fullonia
	Citrus leafminer	Phyllocnistis citrella
	Citrus aphid	Toxoptera spp.
	Cotton aphid	Aphis gossypii
	Cowpea aphid	Aphis craccivora
	Phytorus leaf beetle	Phytorus lineolatus
	Orange spiny whitefly	Aleurocanthus spinifer
	Citrus bark borer	Agrilus occipitalis
	Passion fruit vine bug	Leptoglossus australis
	Fluted scale	Icerya aegyptiaca
	Citrus flower moth	Prays citri
	Weevils	Daealus sp.
	Chinese rose beetle	Adoretus sinicus
5. COCONUT	Mariana coconut beetle	Brontispa marianae
	Longhorned grasshopper	Phisis pectinata
	Walking stick	Acanthegraeffia dentic
	Locust	Valanga excavata
	Coconut weevil	Diocalandra frumenti
	New guinea sugarcane weevil	Rhabdoscelus obscurus
6. CORN	Asian corn borer	Ostrinia furnacalis
	Corn earworm	Heliothis zea
	Southern green stink bug	Nezara viridula
	Chinese rose beetle	Adoretus sinicus
	Corn planthopper	Peregrinus maidis
	Locust	Valanga excavata
	Corn leaf aphid	Rhopalosiphum maidis
	June beetle	Anomala sulcatula
	Mindanao june beetle	Holotrichia mindanaoan
	Pink sugarcane mealybug	Saccharicoccus sacchar
	Plant bug	Creontiades pallidifer
	Maize webworm	Marasmia trapezalis
	Maize leafminer	Pseudonapomyzae spicat

PESTS

	[illegible]	[illegible]
7. CUCURBITS	Cucumber beetles	Aulacophora similis
	Common black garden fleahopper	Halticus tibialis
	Pumpkin caterpillar	Diaphania indica
	Melonworm	Diaphania hylinta
	Cotton aphid	Aphis gossypii
	Cowpea aphid	Aphis craccivera
	Southern green stink bug	Nezara viridula
	Green leafhopper	Empoasca pitiensis
	Cluster caterpillar	Spodoptera litura
	Onion thrip	Thrips tabaci
	Passion fruit vine bug	Leptoglossus australi
	Weevils	Trigonops sp.
	Serpentine leafminer	Liriomyza brassicae
	Leafminer	Acrocercops sp.
8. EGGPLANT	Philippine lady beetle	Epilachna philippiner
	Green leafhopper	Empoasca pitiensis
	Green garden looper	Chrysodeixis chalcite
	Chinese rose beetle	Adoretus sinicus
	Spider mite	Tetranychus cinnabari
	Corn earworm	Heliothis zea
	Southern green stink bug	Nezara viridual
	Cotton aphid	Aphis gossypii
	Green peach aphid	Myzus persicae
	Darkling beetle	Gonocephalus sp.
	Striped mealybug	Ferrisia virgata
	Nigra scale	Saissetia nigra
	Treehopper	Leptocentrus taurus
	Whitefly	Bemisia gossypiperda
	Hornworm	Protoparce sp.
	Serpentine leafminer	Liriomyza sp.
9. MANGO	Phytorus leaf beetle	Phytorus lineolatus
	Mango weevil	Sternochetus magnife
	Orange piercing moth	Othreis fullonia
	Striped mealybug	Ferrisia virgata
	Oleander pit scale	Asterolecanium pustu
	Red-banded thrip	Selenothrips rubroci
	Cowpea aphid	Aphis carccivora
10. OKRA	Green leafhopper	Empoasca pitiensis
	Okra caterpillar	Anomis erosa
	Cotton bollworm	Earis fabia
	Southern green stink bug	Nezara viridula
	Chinese rose beetle	Adoretus sinicus
	Cotton aphid	Aphis gossypii
	Leafminer	Acrocercops sp.

	COMMON	SCIENTIFIC
11. ONION	Onion thrip Cluster caterpillar	*Thrips tabaci* *Spodoptera litura*
12. PAPAYA	Spider mite Broad mite Long brown scale Cotton aphid Green peach aphid Cowpea aphid Onion thrip	*Tetranchus cinnabarinus* *Polyphagotarsonemus latu* *Coccus elongatus* *Aphis gossypii* *Myzus persicae* *Aphis craccivora* *Thrips tabaci*
13. PEPPER	Corn earworm Cotton aphid Weevils Phytorus leaf beetle Broad mite White peach scale Planthopper Serpentine leafminer	*Heliothis zea* *Aphis gossypii* *Trigonops* sp. *Phytorus lineolatus* *Polyphagotarsonemus lat* *Pseudaulacaspis pentago* *Chloriona formosella* *Liriomyza* sp.
14. RADISH	Diamond back moth Cabbage webworm Cluster caterpillar Turnip aphid	*Plutella xylostella* *Hellula rogatalis* *Spodoptera litura* *Rhopalosiphum pesudobra*
15. SWEETPOTATO	Sweetpotato tortoise beetle Sweetpotato weevil Common black garden fleahopper West indian sweetpotato weevil Weevils Weevils Pacific black stink bug Sweetpotato hornworm Whitefly Leafminer Plant bug Sweetpotato beetle Hawkmoth	*Cassida circumdata* *Cylas formicarius elega* *Halticus tiabalis* *Euscepes postfasciatus* *Trigonops* sp. *Daelus* sp. *Brachyplatys insularis* *Agrius cingulatus* *Bemisia gossypiperda* *Acrocercops* sp. *Creontiades pallidifer* *Colasposoma metalicum r* *Herse convolvuli*

16. TARO	Chinese rose beetle	Adoretus sinicus
	Taro sphinx moth	Hippotion celerio
	Cluster caterpillar	Spodoptera litura
	Weevils	Trigonops sp.
	Treehopper	Leptocentrus taurus
	Cotton aphid	Aphis gossypii
	Banana aphid	Pentalonia nigronervosa
	Taro leafhopper	Tarophagus proserpina
	Brown soft scale	Coccus hesperidum
	Fluted scale	Icerya aegyptiaca
	Spider mite	Tetranychus sp.
17. TOMATO	Philippine lady beetle	Epilachna philippinensis
	Corn earworm	Heliothis zea
	Green garden looper	Chrysodeixis chalcites
	Cluster caterpillar	Spodoptera litura
	Green leafhopper	Empoasca vitiensis
	Southern green stink bug	Nezara viridula
	Cotton aphid	Aphis gossypii
	Turnip aphid	Rhopalosiphum pseudobrassica
	Banana aphid	Pentalonia nigronervosa
	Broad mite	Polyphagotarsonemus latus
	Onion thrip	Thrips tabaci
	Gridling bug	Crytopeltis tenuis
	Serpentine leafminer	Liriomyza sp.
18. YAM	Green garden looper	Chrysodeixis chalcites
	Melonworm	Diaphania hylinata
	Coconut scale	Aspidiotus destructor
	Spider mite	Tetranychus
	Thrips	Astrothrips globiceps

LIST OF CROPS AND DISEASES

CROP	DISEASE
AVOCADO	Anthracnose leaf, fruit
BANANA	Bunchy top
	Pseudostem crack & rot
	CMV ---- leaf streak virus
	Sigatoka
	Fruit speck
BEAN, K.W.	Rhizoctonia damping off
	Bacterial leaf spot
	Bean mosaic virus
	Powdery mildew
	Downy mildew
	Leaf spot (fungal)
	Rhizoctonia root rot
BEAN, LONG	Fungal leaf blight
	Bacterial leaf spot
	Downy mildew
	Bean mosaic virus
BITTERMELON	Powdery mildew
CABBAGE, CHINESE	Soft rot
	Nematode
CABBAGE, HEAD (K-K CROSS)	No visible disease
CANTALOUPE	Downy mildew
	Cucumber mosaic virus
	Anthracnose
CASSAVA	Bacterial leaf spot
	Anthracnose
CITRUS	Canker
	Greasy spot (melanose)
	Gummosis
COCONUT	Bristle top
	Leaf spot

[illegible]	[illegible]
CUCUMBER	Cucumber mosaic virus Soft rot (fruit) Powdery mildew
EGG PLANT	Bacterial leaf spot Anthracnose Phomopsis fruit rot Fungal leaf spot
GINGER	Leaf blight Root rot
GUAVA	Anthracnose
HONEYDEW MELON	Cucumber mosaic virus Nematode Powdery mildew Downy mildew
MANGO	Gummosis Anthracnose
OKRA	Anthracnose Rhizoctonia root rot
PAPAYA	Phytophthora leaf blight Papaya ringspot virus Papaya mosaic virus
PASSION FRUIT	Virus
PEANUT	Alternaria leaf spot
PEPPER, BELL	Bacterial leaf spot Anthracnose
PEPPER, HOT	Bacterial leaf spot Anthracnose (fruit)
PINEAPPLE	Fungal leaf spot Tip blight
PUMPKIN	Bacterial leaf spot Powdery mildew Cucumber mosaic virus
SOUR SOP	Anthracnose
SQUASH (LOUFA)	Powdery mildew
SWEET POTATO	Anthracnose Virus

CROP	DISEASE
TARO	Dasheen mosaic virus Phytophthora leaf blight
TOMATO	Early blight Bacterial leaf spot Root knot nematode
WATERMELON	Anthracnose Gummy stem blight Belly rot Blossom end rot Southern blight (fruit)
WING BEAN	Anthracnose
YAM	Rust Anthracnose Fungal leaf spot

PLANT DISEASES OF THE TRUST TERRITORY OF THE PACIFIC ISLANDS

HOST AND DISEASES	PATHOGEN
AVOCADO	
Anthracnose and ripe fruit rot	Glomerella cingulata (in Colletotrichum state)
Stem rot	Sclerotium rolfsii
Die back	Botryodiplodia theobromae
Root rot	Phytophthora cinnamoni
BANANA	
Anthracnose	Colletotrichum musae
Black cross spot	Phyllochora musicola
Bunchy top	Virus
Cordana Leaf Spot	Cordana musae
Finger rot	Botryodiplodia theobromae Colletotrichum musae
Mosaic	Cucumber mosaic virus
Panama wilt	Fusarium oxisporium f. cubense
Sigatoga disease	Mycosphaerella musicola
Black leaf streak	Mycosphaerella sp.
CABBAGE	
Black rot	Xanthomonas campestris
Leaf spot	Corticum sasakii
Mosaic and Yellows	Cucumber mosaic virus
Soft Rot	Erwinia caratovora
CITRUS	
Anthracnose	Glomerella cingulata (in Colletotrichum state)
Blue and Green mold	Penicillum sp.
Canker	Xanthomonas citri
Felt fungus	Septobasidium sp.
Foot rot, Gummosis and brown spot	Phytophthora sp.
Melanose	Diaporthe citri
Sooty mold	Capnodium citri (associated with insect)
CACAO	
Black pod and Canker	Phytophthora palmivora
Brown pod and Canker	Botryodiplodia theobromae
Thread Blight	Corticium sp.

LIST OF DISEASES ATTACKING ECONOMIC CROPS
TRUST TERRITORY OF THE PACIFIC ISLANDS

Disease	Cause
AVOCADO	
Root rot	Phytophthora cinnamoni
Anthracnose	Glomerella cingulata
Bark Canker	Dothiorella sp.
Die back	Botryodiplodia theobroniae
BANANA	
Sigatoka	Mycosphaerella musicola
Bunchy Top	Virus
Panama Wilt	Fusarium oxysporium f. cubense
Rhizome Rot	Pectobacterium
Black Head	Diplodia musae
Anthracnose	Colletotricum musae
Large Leaf Spot	Helminthosporium tortulosum
Speckle	Phyllostictina musarum
Diamond Spot	Cordana musae
BEANS	
Anthracnose	Colletotrtum lindemuthianum
Halo Blight	Xanthomonas phaseoli
Root Rot	Fusarium solani f. phaseoli
Southern Blight	Sclerotium rolfsii
Rust	Uromyces phaseoli
Leaf Spot	Cercospora canescens
~~Chlorosis~~	~~Nutritional~~
~~Algal Spot~~	~~Cephaleuros virescens~~
Watery Soft Rot	Sclerotinia sclerotiorum
Alocasia	

COCONUT

Bleeding Disease	Ceratocystis paradoxa
Bud rot	Phytophthora palmivora
Grey leaf spot and Blight	Pestalotiopsis palmarum
Seedling Blight	Helminthosporium incurvatum
Thread Blight	Corticium penicillatum

COFFEE

Brown eye spot and berry blotch	Cercospora coffeicola
Rust	Hemileia vastatrix
Thread Blight	Corticium kaleroga

TARO

Corm Rot	Phytophthora sp.

SACCHARUM EDULE

Leaf scald	Xanthomonas albilineans
Red rot	Glomerella tucumanensis
Rust	Puccina kuehnii
Yellow spot-	Cercospora koepkei

EGGPLANT

Anthracnose	Glomerella cingulata
~~Root-knot--------------- -------------~~	~~Meloidogyne-incognita~~

GINGER

Root knot	Meloidogyne incognita

HARICOT BEAN

Pod rot	Rhozoctonia sp.

SWEET POTATO

Leaf Spot	Cercospora batatas
Scab	Elsinoe batatas

MAIZE

Leaf spot	Cochliobolus heterostrophus
Rust	Puccina palvasora
Sheat and Pink ear rot	Giberella fusikuroi

MANGO	
Anthracnose	Glomerella cingulata (in Colletotrichum state)
ONION	
Neck rot	Glomerella sp. Aspergillus flavus
PAPAYA	
Fruit and Root rot	Phytophthora nicotianae var. parasitica
Ripe fruit rot	Botryodiplodia theobromae Fusarium spp. Glomerella spp. Rhizopus sp.
Shothole	Corynespora sp.
PINEAPPLE	
Base rot	Ceratocystis paradoxa
Heart and root rot	Phytophthora sp.
COWPEA, LONG BEANS	
Leaf spot	Cercospora cruenta
Powdery mildew	Erysiphe polygoni (in Oidium state)
Rust	Uromyces appendiculatus
RICE	
Brown spot	Cochliobolus miyabinus (in Helminthosporium state)
Sheath rot	Corticium sasakii
TAPIOCA	
Leaf spot	Cercospora heinningsii
TOBACCO	
Mosaic	Tobacco mosaic virus
TOMATO	
Bacterial wilt	Pseudomonas solanacearum
Mosaic	Tobacco mosaic virus
YAM	
Leaf spot	Cercospora sp.

COMMON INSECT PESTS IN THE TRUST TERRITORY OF THE PACIFIC ISLANDS

(9/78)

CROP	INSECT PEST	COMMENTS
Coconut	Rhinoceros beetle	The copra industry in [illegible] Is. was almost wiped out by this. Biological control in insects has succeeded in recent years.
Snap Beans	Stinkbug	Serious on commer. Varieties such as Kentucky Wonder. Local varieties not as badly affected.
Cabbage	Cabbage Looper	Moderate to severe damage
Chinese Cabbage	Fleahopper	Light to moderate
Corn (Sweet & field)	Grasshopper; aphids	light
Eggplant	Mite; Mealy Bug; Stinkbug	Light to moderate
Cucumber	Fleahopper; [illegible] Aphid	Moderate to severe Slight to moderate
Okra	Larval forms of certain moths	Moderate to severe
Onion, bunching	Thrip	
Pepper, sweet	Mite	Severe during dry periods
Sweet potatoes	Fleahopper	Moderate
Tomato	Leaf miner Caterpillar Mite	Moderate Moderate Moderate

Some Observations on Insect Problems on Ponape

1. Ponape and the Caroline Islands do not have several of the insect pests which cause considerable damage in Hawaii and other islands in the Pacific: White Fly; Mediterranean and Asiatic Fruit Flies.

2. Insect damage has not yet been serious enough to warrant a regular insecticide spray program. Occasionally it is necessary to use insecticides to control the following:
   Loopers on Cabbage
   Mites on peppers and tomatoes (only during the dry season)

3. Fleahopper: Halticus fibialis. (a Miridae moth in the Hemiptera order). Effects moderate to serious damage to leaves of cucumber, sweet potatoes and chinese cabbage. Of the 3, the damage to sweet potatoes has been the greatest; however the vegetation grows so fast that it is felt that the damage is only minimal and does not justify a spray program.

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

SAIPAN, CM 96950

APPENDIX III

PARASITES AND PREDATORS OF CROP PESTS (CNMI, GUAM, AND TRUST TERRITORY OF THE PACIFIC ISLANDS)

Pest	Host	Parasite/predator	Present sta
Achatina fulica Bowdich African snail, Pulmomata:Achatinidae	Various plants	Gonaxis kibweziensis (Smith)	E
		Gonaxis quadrilateralis (Preston) Pulmonata:Streptaxidae	?
		Euglandina rosea (Ferussac) Pulmonata:Oleacinidae	E
Adoretus sinicus Burmeister Chinese rose beetle, Coleoptera:Scarabaeidae	Banana, beans, corn, cabbage, citrus, eggplant, okra taro.	Campsomeris marginella modesta (Smith) Hymenoptera:Scoliidae	E
		Tiphia segregata Crawford Hymenoptera:Tiphiidae	E
Aleurocanthus spiniferus (Quaintance) Orange spiny whitefly, Homoptera:Aleyrodidae	Citrus spp.	Amitus hesperidum Silvestri Hymenoptera:Platygasteridae	E
		Eretmocerus serius Silvestri	?
		Prospaltella smithii Silvestri	E
		Prospaltella clypealis Silvestri	?
		Prospaltella opulenta Silvestri Hymenoptera:Aphelinidae	?
Anomala sulcatula Burmeister June beetle, Coleoptera:Scarabaeidae	All grasses and grain crops.	Campsomeris annulata (F.)	E
		Campsomeris manokwariensis Humenoptera:Scoliidae	?

E = Established NE = Not established ? = Established not known N = Nati

Pest	Host	Parasite/predator	
Aonidiella comperei Mckenzie Fasciated scale, Homoptera:Diaspididae	Coconut, citrus, Papaya.	Refer Aspidiotus destructor	
Aphis gossypii Glover Cotton aphid, Homoptera:Aphididae	Breadfruit, citrus, cucurbits, eggplant, okra, pepper, taro tomato	Aphelinus sp. Hymenoptera:Aphelinidae	E
		Coccinella transversalis (F.) Coelophora inaequalis (F.) Harmonia arcuata (F.) Orcus chalybeus (Boisduval) Playtysmus lividigaster Mulsant Coleoptera:Coccinellidae	E E E ? ?
		Ischiodon scutellaris (F.) Syrphus pusillus Macquart Diptera:Syrphidae	E N
Aspidiotus destructor Signoret Coconut scale, Homoptera:Diaspididae	Banana, breadfruit, betel palm, mango, papaya, yam, taro.	Aphytis chrysomphalis (Mercet) Hymenoptera:Aphelinidae	N
		Comperiella ', fasciata How. Hymenoptera:Encyrtidae	NE
		Azya trinitatis Marshall Crytogonus orbiculus var.nigripennis Wiese Crytogonus nodiceps Marshall Lindorus lophanthae Boisduval Pseudoscymnus anomalus Chapin Telsimia nitida Chapin Coleoptera:Coccinellidae	? E ? NE N N
		Chelisoches morio (F.) Dermaptera:Labiidae	E
Brontispa mariana Spaeth Mariana Coconut beetle Coleoptera:Chrysomelidae	Coconut	Haeckeliana brontispae Ferriere Hymenoptera:Trichogrammatidae	NE
		Tetrastichus brontispae (Ferriere) Hymenoptera:Eulophidae	N

pillars (Lepidoptera)	Various plants	Polistes macaensis (F.) Pachodynerus nasidens (Latreille) Phynchium brunneum (F.) Hymenoptera:Vespidae	N N N
deixis chalcites (Esper) garden looper, optera:Noctuidae	Beans, eggplant, tomato, yam	Echthromorpha conopleura Krieger Hymenoptera:Ichneumonidae	N
olites sordidus (Germer) Banana root borer, Coleoptera:Curculionidae	Banana	Hololepta minuta Erichson Hololepta quadridentata (F.) Plaesius javanus Erichson Coleoptera:Histeridae	? ? E
ickets (Orthoptera)	Various	Liris aurata (F.) Notogonidae minilae (Ashmead) Hymenoptera:Larridae	N N
spp. flies, ra:Trypetidae	Various fruits	Opuis fletcheri Silvestri Opius watersi Full. Opius vandenboschi Full. Opius longicaudatus (Ashmead) Opius incisi Silvestri Opius formosanus Full. Opius compensans (Silvestri) Hymenoptera:Braconidae	? ? ? ? ? ? ?
		Dirhinus giffardii Silvestri Hymenoptera:Chalcididae	?
		Aceratoneuromyia indicum (Silvestri) Hymenoptera:Eulophidae	?

Pest	Host	Parasite/predator	Present status
Diaphania indica (Saunders) Pumpkin caterpillar, Lepidoptera:Pyralidae	Cucurbits	*Trathala flavo-orbitalis* (Cameron) Hymenoptera:Ichneumonidae	E
Erionota thrax L. Banana skipper, Lepidoptera:Hesperiidae	Banana	*Apanteles erionatae* Wilkinson Hymenoptera:Braconidae	E
Epilachna philippinensis Dieke Philippine lady beetle, Coleoptera:Coccinellidae	Solanaceous plants	*Paradexoides epilachnae* Aldrich Diptera:Tachinidae	NE
		Pediobius epilachnae Rohwer Hymenoptera:Eulophidae	?
Dysmicoccus boninsis (Kuwana) [illegible] mealybug, Homoptera:Coccidae	Sugarcane, sorghum, large grasses.	*Crytoplemus montrouzieri* Mulsant Coleoptera:Coccinellidae	E
Ferrisia virgata (Cockerell) Striped mealybug, Homoptera:Pseudococcidae	Breadfruit, citrus, coconut, cucurbits, eggplant, mango, pineapple, taro, tomato	*Crytoplemus montrouzieri* Mulsant	N
		Nephus sp. Coleoptera:Coccinellidae	N
		Blepyrus insularis (Cameron) Hymenoptera:Encytridae	E
Furcaspis oceanica Lindinger Red coconut scale, Homoptera:Diaspididae	Coconut, pandanus	*Anabrolepis oceanica* Doutt Hymenoptera:Encytridae	?
Grasshopper nymphs (Orthoptera)	Various plants	Polistes macaensis (F.) Hymenoptera:Vespidae	N
Agrius convolvuli (L.) Hawkmoth, Lepidoptera:Sphingidae	Sweetpotato, taro	*Trichogramma minutum* Riley Hymenoptera:Trichogrammatidae	E

Icerya aegyptiaca (Douglas) Fluted-scale, Homoptera:Margarodidae	Banana, breadfruit, citrus, coconut, cucurbits, taro	Harmonia arcuata (F.) Rodolia cardinalis Mulsant Rodolia pumila Weise Coleoptera:Coccinellidae	N ? E
Lepidoptera Leafroller caterpillars,	Various plants	Iceria marginata (Lepeletier) Hymenoptera:Vespidae	N
Marasmia trapezalis (Guenee) Maize leafroller, Lepidoptera:Pyralidae	Corn	Apanteles guamensis (Holmgren) Hymenoptera:Braconidae	E
Musca spp. Flies, Diptera:Muscidae	Filth	Spalangia cameroni Perkins Hymenoptera:Pteromalidae	E
		Copris incertus var. prociduus Say Coleoptera:Scarabaeidae	?
Aedes, Anopheles, Culex Mosquitoes, Diptera:Culicidae	Man	Toxorhynchites brevipalpus Theob. Toxorhynchites splendens (Wied.) Culex fuscanus Weidemann	? ? ?
Nacoleia diemanalis (Guenee) Bean leafroller, Lepidoptera:Pyralidae	Beans	Refer Chrysodeixis chalcites (Esper)	
Ostrinia furnacalis (Guenee) Asian corn borer, Lepidoptera:Pyralidae	Corn	Exeristes roborator (F.) Trathala flavo-orbitalis (Cameron) Horogenes punctorius (Roman) Eulimneria alkae (E & S) Hymenoptera:Ichaeumonidae	NE E ? NE
		Lydella stabulans grisescens (Robineau-Desvoidy) Diptera:Tachinidae	

Pest	Host	Parasite/predator	Present status
Ostrinia furnacalis (continued)		Chelonus annulipes Wesm. Marocentrus giffuensis (Ashmead) Hymendptera:Braconidae	? ?
Papilio polytes L. Citrus swallowtail, Lepidoptera:Papilionidae	Citrus	Pteromalus luzonensis Hymenoptera:Pteromalidae	E
Peregrinus maidis (Ashmead) Corn planthopper, Homoptera:Delphacidae	Corn	Crytorhinus lividipennis Reuter Hemiptera:Miridae	E
		Anagrus flaveolus Waterhouse Hymenoptera:Mymaridae	E
Pseudonapomyza spicata (Malloch) Corn leafminer, Diptera:Agromyzidae	Corn, sugarcane, many other plants of Gramineae	Hemiptarsenus semialbiclava (Girault) Hymenoptera:Eulophidae	E
Pseudaulacaspis pentagona (Targi.) White peach sacle, Homoptera:Diaspididae	Breadfruit, casava, pepper	Lindorus lophanthae (Boisduval) Telsimia nitida Chapin Coleoptera:Coccinellidae	NE N
Rhabdoscelus obscurus (Boisduval) New Guinea sugarcane weevil, Coleoptera:Curculionidae	Corn, sugarcane ETC.	Refer Aphis gossypii Clover	
Saccharicoccus sacchari (Cockerell) Pink sugarcane mealybug, Homoptera:Pseudococcidae	Corn, sorghum, rice, sugarcane and large grasses.	Crytoplaemus montrouzieri Mulsant Coleoptera:Coccinellidae	E
Saissetia nigra (Nietner) Nigra scale, Homoptera:Coccidae	Casava, citrus coconut, eggplant, pandanus	Tomocera californica Howard Hymenoptera:Miscogasteridae	E
		Anysis alcocki (Ashmead) Hymenoptera:Pteromalidae	?

P[illegible]	Host	Parasite/predator	
Saissetia nigra (Nietner) (continued)		Aneristus ceroplastae Howard Hymenoptera:Eulophidae	?
Saissetia coffeae (Walker) Homoptera:Coccidae	Citrus	Aphycus helvolus Comp. Aphycus lounsburyi Howard Aphycus luteolus Timb. Aphycus stanleyi (Comp.) Hymenoptera:Encyrtidae	E E ? ?
		Cocophagus lycemia rusti (Comp.) Hymenoptera:Aphelinidae	?
		Scutellista cyanea Motsch Hymenoptera:Ptromalidae	E
[illegible] litura (F.) caterpillar, [illegible]:Noctuidae	Beans, cabbage, cucurbits, taro, tomato etc.	Telenomus nawai Ashmead Hymenoptera:Sceloinidae	E
[illegible] proserpina (Kirkaldy) [illegible]hopper, [illegible]:Delphacidae	Taro	Crytorhinus fulvus Knight Hemiptera:Miridae	E
		Haplogonatopus vitiensis Perkins Hymenoptera:Dryinidae	E
		Echthrogonatopus exitiosus Perkins Humenoptera:Encrytodae	E
[illegible]ychus (T.) kanzawai Kishida [illegible] mite, [illegible]:Tetranychidae	Yam	Amblyseius longispinosus (Evans) Acarina:Phytoseiidae	N

MAJOR INSECT PESTS OF MICRONESIA

Introduction:

Insects are a part of life in Ponape and as such are very important in local agriculture. There are literally thousands of insect species on Ponape, but only a few are actually pests of economic importance. This paper attempts to give a brief overview of the major insect agricultural pests in Ponape, and their identification and control. The major insect pests covered are spidermites, grasshoppers, aphids, leafhoppers, stinkbugs, weevils, fleahoppers, Tortoise Beetles, leafminers, and worms (larva).

1. Spidermites:

Spidermites are not true insects but rather belong to the Arthropod family, which also includes lobsters and spiders. They are not a real important pest in Micronesia because they prefer hot, dry climates. They can however become troublesome during dry periods on Ponape. These tiny animals feed on plant leaves, especially those of bell pepper, cucurbits (cucumber, pumpkin, squash, etc.), tomato, and beans. Their sucking causes the leaves to turn a yellowish-brown and on severely affected plants, the leaves may be covered with webbing and cast skins. They lay eggs on the leaf surface and populations can build up very quickly. They prefer full sunlight and are not such a problem on shaded plants.

Spidermites are hard to control with out chemicals, but they can be prevented by proper field sanitation (destroying crop residues, weeding, and keeping clean borders around fields) and proper irrigation. KELTHANE, a miticide spray, can also be used when infestations are severe.

2. Grasshoppers:

Grasshoppers are true insects of the the order Orthoptera, which also includes mantids and cockroaches. The are chewing insects that feed on a great variety of different plants, mainly eating the leaves. On Ponape, they can be pests on corn, cucurbits, and tomato. They usually don't cause much damage, unless their population builds up to great numbers.and rarely need to be controlled. They are highly mobile, thanks to their enlarged back legs and wings on the adults.

They can usually be controlled by good field sanitation. The insecticide SEVIN also can be used successfully but is rarely needed.

3. Aphids:

Members of the insect order Homoptera, there are many types of aphids in Ponape, and many are pests to specific plant species.

There are types of aphids which feed on cucurbits, corn, chinese and head cabbage, eggplant, bell pepper, tomato, beans, and banana. They are a very serious plant pest- they suck plant juices and cause the plant leaves to curl and wilt, and they can also transmit several plant diseases. They are usually found in groups on the bottom of the leaves of infested plants, but can also infest stems and roots. They can also multiply rapidly because of their ability to give birth to live young.

Aphids also discharge a sweet, sticky juice, honeydew, from their anus while feeding, and this attracts ants and other insects and funguses. Ants have been known to carry aphids and place them on plants to get them to produce honeydew. Aphids do not move much on the plant, and although the adults are winged they rarely fly.

Aphids are kept under control by several natural predators, but spraying insecticides to control other insect pests often kills off these predators and allows aphid populations to grow until they become a problem. Field sanitation helps to cut down on alternate hosts for the aphids, and thus can cut down infestations. On small plots, they can also be washed off with soap and water, and a spray made of ground chili pepper and water has also been successful. If damage continues, the insecticides DIBROM, MALATHION, and CYGON have been used successfully in Ponape.

4. Leafhoppers:

Also of the order Homoptera, leafhoppers are also numerous in the tropics and Ponape and there are several kinds specific to certain plants. In Ponape, they can be a pest on corn, bell pepper, and tomato. They are small (less than 10 mm) and often brightly colored. Like aphids, they are serious pests causing injury by sucking and can transmit several plant diseases. They differ from aphids in that they are highly mobile, jumping from plant to plant while feeding. Like aphids, they also excrete honeydew.

Control of leafhoppers can also be helped by proper field sanitation and protection of natural predators. In severe infestations, insecticides such as DIBROM may be needed.

5. Stinkbugs:

Stinkbugs are members of the true bug order Hemiptera and are quite common in Ponape, being pests of cucurbits, tomato, and beans. Two species, the green stinkbug (1/2 inch in size) and the smaller black stinkbug (1/4 inch in size) are especially common. They are sucking insects and cause damage by sucking plant juices, especially on new plant growth, causing stunting and weakening of the plant. Their name comes from the disagreeable odor that they emit.

They are difficult to control, but crop rotation (not growing the same crop on the same piece of land (continuously) and field sanitation helps somewhat. If they reach high populations, spraying with SEVIN is recommended.

6. Fleahoppers:

Also a Hemipteroid. fleahoppers are numerous on Ponape. They are easily recognizable as a small black bug that actively jumps and runs around plants, especially young seedlings. In Ponape it can cause damage to cucurbits, chinese and head cabbage, beans, sweet potato, and many other plants. It is a sucking insect and toxin from it's saliva causes numerous white spots to appear on the surface of the leaf. Their feeding weakens and stunts the young plants.

Keeping the garden and borders free of weeds can give some control, but many times an application of SEVIN or DIBROM may be needed for complete control.

7. Weevils:

Weevils are of the order Coleoptera, the beetles. They are very common on Ponape, especially as pests of stored grains- rice, flour, and corn, and seeds. They are chewing insects that make holes in fruits, seeds, and nuts of many plants, and they can be major pests of crops in storage.

Control is by proper storage methods: drying all seed and grain to below 12% moisture, cold storage, and with seed, an addition of MALATHION dust to the seed before storage. DO NOT USE MALATHION ON SEED OR GRAIN TO BE USED FOR HUMAN OR ANIMAL FEED.

Another member of the weevil family is the Sweet Potato weevil, a major sweet potato pest, which has possibly reached Ponape. It chews on the sweet potato tubers and then lays eggs in the holes. The eggs hatch and the young larva (worms) eat through the tuber and stems. These weevils can cause widespread destruction and if found should be reported immediately to the Agriculture Station.

Control of the Sweet Potato weevil is accomplished by cultural means: clean planting material, crop rotation, hilling-up, harvesting early (90-120 days), and resistant varieties. Spraying insecticides gives control of the weevil but the destruction of beneficial insects causes heavy increases in damage by leafminers, another sweet potato pest.

8. Tortoise Beetle:

Also Coleoptera. this is a widely distributed sweet potato pest. It was introduced to Guam in 1945 and later to the other islands of Micronesia. It is a small, round shiny-green beetle with a black horse-shoe shaped spot on it's shell. It chews holes in the sweet potato leaves and in heavy infestations, can completely defoliate plants, causing drastically reduced yields.

Control is difficult once the beetle is established. Crop rotation is an important cultural control and great care should be taken not to introduce the Tortoise Beetle into new areas. This can be done by sterilizing any planting material from infested fields with an insecticide. Spraying fields with MALATHION has given control, but this is costly and can also result in outbreaks of other pests like the leafminer.

9. Leafminer:

Leafminers can be members of Coleoptera, Lepidoptera (the butterflies and mothes), Diptera (the flies), or Hymenoptera (the wasps). In each case the adults lay eggs on the leaf of the plant and when these hatch the young larva feed within the leaf leaving clearly visible white lines (from the tunnels). This can weaken the plant, and in the case of chinese and head cabbage, can make the plant completely unmarketable. They are also pests on beans and cucurbits.

In most cases, leafminers are kept under control by natural predators. However, when insecticides are sprayed to control other insect pests, these predators are also killed and leafminers are allowed to multiply and become damaging. In cases of severe damage, CYGON and DIBROM can be used at recommended rates.

10. Worms:

The major worm pests- the cabbage worm, the corn earworm, the tomato fruitworm, etc. are all of the order Lepidoptera. The adult moth lays eggs on the leaves or fruit of the host plant- corn, cucurbits, beans, chinese and head cabbage, tomato, *sweet potato, etc.- and the young larva (worms or caterpillars) hatch and start to feed by chewing. After they have fed for a few days they pupate (go into dormancy) after which they emerge as adults, mate, and continue the cycle. They can cause nearly complete destruction of crops like head cabbage. Other worms, like the Sweet Potato Weevil, are Coleoptera (beetles), and through a similar life cycle, they bore holes in tubers and fruit, and cause much destruction.

Much control of worms can be accomplished through cultural means: crop rotation, field sanitation, intercropping (where two or more crops are mixed together in a single area, confusing the adult insects), and resistant varieties. Hand-picking of larva also helps to control them, as does a spray of chili pepper and water. Bacillus thuringensis, a biological pesticide with no danger to humans, marketed under the name of DIPEL, is also effective against many of the Lepidopterous larva. If damage continues to be heavy, insecticides such as DIBROM, MALATHION, and SEVIN can give control, depending on the type of worm pest.

Summary

These are the ten major insect pests that are presently agricultural problems in Ponape. In most cases, control of these insects can be accomplished through cultural methods mentioned throughout this paper: field sanitation, crop rotation, proper care and irrigation, if necessary, inter-cropping, clean planting material, hand-picking of insects, and use of resistant varieties. Chemical insecticides should be used only as a last line of defense against these pests, because they are dangerous, expensive, and many times do more harm than good by destroying beneficial insects. If chemicals must be used, due to uncontrollable insect infestations, assistance should first be sought at the State Agricultural Station to correctly identify the pest and properly select and use the insecticide.

Furthermore, continuous care must be taken by farmers, especially in the transport of planting material into and around Ponape, to see that insect pests that have not yet entered or spread around the island are not inadvertently assisted.

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GLOSSARY OF ACRONYMS

AID	(United States) Agency for International Development
CTAHR	(Hawaiian) College of Tropical Agriculture and Human Resources
EPA	Environmental Protection Agency
FAO	(United Nations) Food and Agricultural Organization
IPM	Integrated Pest Management
SIRM	Sterile Insect Release Method
SPC	South Pacific Commission
USDA	United States Department of Agriculture